2009
LUMMI NATION
WATER QUALITY ASSESMENT REPORT

JUNE 28, 1993 TO DECEMBER 31, 2009

April 2010

Water Resources Division

Lummi Natural Resources Department

Lummi Indian Business Council

2009
LUMMI NATION
WATER QUALITY ASSESSMENT REPORT
JUNE 28, 1993 TO DECEMBER 31, 2009

Prepared For:
Lummi Indian Business Council
(LIBC)

Funded By:
Environmental Protection Agency
(Grant No. BG-97042602-3)

Prepared By:
Water Resources Division
Lummi Natural Resources Department

Contributors:

Jeremy Freimund, P.H.	Water Resources Manager
Jean Snyder	Water Resources Specialist II
Craig Dolphin	Database Development Specialist
Jamie Mattson	Water Resources Specialist I
Victor Johnson	GIS/Water Resources Technician III

Date
April 2010

This project has been funded wholly or in part by the United States Environmental Protection Agency under Assistance Agreement BG-97042602-3 to the Lummi Nation. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

EXECUTIVE SUMMARY

The goals of the Lummi Nation Surface Water Quality Monitoring Program (Program) are to:

a) Document ambient water quality and water quality trends on the Lummi Indian Reservation (Reservation);
b) Evaluate regulatory compliance of waters flowing onto the Reservation, including compliance with Lummi Nation Surface Water Quality Standards;
c) Support the development and implementation of water quality regulatory programs on the Reservation.

The purpose of this report is to:

a) Present the surface water quality data collected during the calendar year 2009;
b) Compare the 2009 results to data from the period of record;
c) Present interpretations of these data with respect to the Program goals;
d) Provide the U.S. Environmental Protection Agency (EPA) documentation required pursuant to the *Final Guidance of Awards of Grants to Indian Tribes under Section 106 of the Clean Water Act* (EPA 2006).

Water quality on the Reservation is complex for several reasons. The Reservation consists of approximately 38 miles of marine shoreline and 7,000 acres of tidelands. It is located in the estuaries of the Lummi River and the Nooksack River where marine and fresh water interact; the water column may have varying degrees of salinity-based stratification. In addition, water can flow upstream, downstream, or be stagnate at many of the sampling sites depending on the tides and weather conditions. Upland sites become saline or dry during the summer months as the dry season progresses. Once the wet season begins during October or November, upland flow increases, diluting many of the saline monitoring sites with fresh water.

The water quality parameters measured at the monitoring sites during 2009 generally followed the trends of 2003 through 2008 with higher bacteria levels, higher temperatures, and lower dissolved oxygen levels compared to the improvements in these parameters observed during 2000 and 2001. However, fecal coliform bacteria levels in the main stem of the Nooksack River at the Reservation border (SW118) have improved during 2009 compared to the trends of 2003 through 2007. During 2009, fecal coliform bacteria levels at Site SW118 were lower than the Total Maximum Daily Load (TMDL) target of a geometric mean of 39 coliform forming units/100 ml established for the lower Nooksack River (Ecology 2000 and 2002) but still exceeded the water quality standards for Class AA fresh water bodies because the 90^{th} percentile standard was exceeded.

The water quality is generally more degraded at the sites further inland, and gradually improves downstream towards the marine waters on the Reservation. The Lummi River watershed continues to have the poorest water quality of the sites sampled on the Reservation whereas the marine waters of Lummi Bay and the Sandy Point Channel continue to maintain relatively good water quality. Sampling of the Nooksack River indicated variable water quality with elevated readings during 2009 that remain a cause of concern despite observed improvements compared to the 2003 to 2007 period. The overall pattern since 2003 of decreasing water quality in the Nooksack River and in Portage Bay and the continuing poor water quality in the Lummi River and the tributaries to Lummi Bay particularly with respect to increased fecal coliform bacteria contamination is a major concern. The members of the Lummi Nation use Portage Bay and Lummi Bay shellfish beds for ceremonial, subsistence, and commercial purposes and elevated fecal coliform levels could close these shellfish beds to harvest.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The purpose of this introductory section is to present the goals of the Lummi Nation Surface and Ground Water Quality Monitoring Program (Program), identify Program staff changes during the reporting period, summarize Program improvements during 2009, and to provide an outline of the report contents.

1.1. Purpose Statement

The Program was initiated in June 1993 to establish the ambient conditions of Reservation surface waters, which are a component of the Lummi Nation Waters. This information is used to evaluate regulatory compliance of waters flowing onto the Reservation including compliance with Lummi Nation Surface Water Quality Standards (LWRD 2008); to identify and track water quality trends; and to support the development and implementation of water quality regulatory programs on the Reservation.

The purpose of this report is to describe the Lummi Nation Water Quality Program and to present the surface water quality data collected during calendar year 2009; compare the 2009 results to data from the period of record, and present interpretations of these data with respect to the Program goals. This report is also intended to provide the U.S. Environmental Protection Agency (EPA) documentation required pursuant to the *Final Guidance of Awards of Grants to Indian Tribes under Section 106 of the Clean Water Act* (EPA 2006).

This report contains data collected pursuant to associated work plans and grant agreements between the Lummi Nation and the EPA. The data collected between January 1 and December 31, 2009 are presented in tabular form in Appendix A. These data will be exported to EPA's Water Quality Exchange Network (WQX) during the second quarter of the 2010 calendar year. The data collected over the period of record will be exported to WQX after quality assurance reviews are completed (targeted for December 31, 2010).

1.2. Program Staff Changes

Although the Water Resources Manager of the Lummi Water Resources Division (LWRD) of the Lummi Nature Resources Department (LNR) is responsible for the overall success of the Program, the responsibility for the operation of the Program is delegated to the Water Resources Specialist. In the past, the Water Resources Specialist supervised a Water Resources Technician, who performed most of the water quality sampling and data entry. The Water Resources Specialist left LNR during the spring of 2005, after 12 years of service including the initiation and development of the Program. The Water Resources Technician also resigned during the spring of 2005 after 7 years of service. These positions were filled during the spring and early summer of 2005, but both positions were again vacated during July and August 2006. The Water Resources Specialist position was refilled in October 2006 and the Water Resources Technician position was filled in February 2007. As these two staff members are the primary staff responsible for program implementation, and several months were required each time to select, hire, and train the replacements, substantially fewer water quality samples were collected during 2005, 2006, and 2007 relative to previous years.

During winter of 2008, a GIS/Water Resource Technician III was hired to assist with water quality sampling. Training and familiarization with the program continued during the first half of 2008. During the second half of 2008, the Program stabilized and the frequency of sampling approached the schedule described in the *Lummi Nation Water Quality Monitoring Program Quality Assurance/Quality Control Plan – Version 3.0* (LWRD 2006a). During the spring of 2008, the Water Resources Specialist position was again vacated and the position was not re-filled until October 2008. During this period, the Water Resources Technician III was promoted to Water Resource Specialist I and assigned to lead the field data collection elements of the Program. The Program now consists of a Water Resource Specialist I and a GIS/Water Resource Technician III with additional support provided by a Water Resource Specialist II.

1.3. Program Improvements

When the Program was initiated in 1993, the collected data were recorded in field books and lab reports and then transcribed into computerized spreadsheets for analysis. The need to develop a database to manage the collected data was recognized by 1996 but the staff and financial resources needed to develop the database were not available. As more and more data were collected, the need to develop a database became increasingly urgent. Starting in 2005, an effort was initiated to develop improved data storage, management, and analysis capabilities. The first version of the resultant database was completed during 2006 (LWRD 2006b) and was initially populated with the water quality data from 2006. Because of the new database structure, the historic data stored in spreadsheets could not be simply imported electronically into the new database. As a result, a contractor was hired during 2007 and 2008 to enter all of the surface water quality data for the period from 1993 through 2008 into the new database. This task was completed in early October 2008. The current Water Resources Specialist I entered all of the November and December 2008 data and all subsequent data into the database. Historic data collected by the Washington Department of Health (DOH) in Portage Bay and in Lummi Bay is still being entered into the database. The data for the 1993 through 2006 period still needs to be reviewed for quality assurance and, as described above, this review is targeted for completion by December 31, 2010.

As part of the database development effort, standardized field data collection forms were developed to ensure that the required data were collected in the field and to facilitate the input of collected data into the database.

In addition to the database developed in-house, a data analysis tool developed by Utah State University (USU) as part of the WRIA 1 Watershed Management Project (www.wria1project.whatcomcounty.org) became available. The LWRD database can export data in a format compatible with the USU data analysis tool, the STORET database, or the Excel spreadsheet program. The database is also able to perform limited analyses of the data. The graphical presentation in this summary report includes products that originate directly or indirectly from the LWRD database. The LWRD database needs to be modified to export the data to the WQX database.

1.4. Report Overview

This report is organized into the following sections.

- Section 1 is this introduction.
- Section 2 is a description of the Lummi Nation waters and the Lummi Nation's water resources management program.
- Section 3 is a description of the surface and ground water quality monitoring objectives.
- Section 4 is a description of the Lummi Nation's surface and ground water quality assessment methods.
- Section 5 is a summary of the Lummi Nation Surface Water Quality Standards.
- Section 6 presents a comparison of the results from 2009 and the period of record to the Lummi Nation Surface Water Quality Standards and identifies trends in key water quality parameters at representative sites.
- Section 7 is a discussion of the water quality sampling results.
- Section 8 is a summary and conclusion section.
- Section 9 is a list of references cited in this report.
- Appendix A presents the 2009 surface water quality data in tabular form.

(This page intentionally left blank)

2. LUMMI NATION DESCRIPTION

The purpose of this section of the report is to describe the Lummi Indian Reservation location, Lummi Nation water resources management program, and provide an overview of the Lummi Nation Waters.

2.1. Lummi Indian Reservation

The Lummi Indian Reservation (Reservation) is located in the northwest corner of Washington State (Figure 2.1). The Lummi Nation is a federally recognized tribe with the Lummi Indian Business Council (LIBC) and General Council as its governing body. There are more than 4,300 enrolled members of the Lummi Nation. The Reservation is located along the western boundary of Whatcom County, Washington adjacent to Georgia Strait and Puget Sound. The Reservation includes portions of the Nooksack River and Lummi River watersheds, which drain into Bellingham Bay, Hale Passage, and Lummi Bay. The Nooksack River drains a watershed of approximately 786 square miles, enters the Reservation near the mouth of the river, and discharges to Bellingham Bay (and partially to Lummi Bay during high flows). The Reservation is located approximately 8 miles west of Bellingham, 90 miles north of Seattle, and 60 miles south of Vancouver, British Columbia, Canada. The 2003 to 2004 Lummi Tribal Data Resource (TDR) project reported that the total Reservation population was estimated at 6,590 people; 2,564 (48.9%) of the residents identified themselves as an enrolled Lummi tribal member or related to a Lummi tribal member.

2.2. Lummi Nation Water Resources Management Program

The Reservation is comprised of about 12,500 acres of upland and 7,000 acres of tidelands. Approximately 38 miles of highly productive marine shoreline surround the Reservation on all but the north and northeast borders. Much of the high-density development to date has occurred along the marine shoreline. Several new residential developments are planned for construction throughout the Reservation beginning during the summer 2010. The Reservation includes the Nooksack and Lummi River deltas, tidelands, forested uplands, Portage Island, and the Sandy Point Peninsula. Both the Nooksack and Lummi River watersheds are under environmental pressures from rapid regional growth. The Lummi Nation has also entered a period of economic development under self-governance. Growth on and near the Reservation requires that the Nation's core environmental program prioritize the development of a regulatory infrastructure that is technically sound, legally defensible, and administratively efficient. This regulatory infrastructure needs to allow for growth while protecting tribal resources and the Reservation environment. This infrastructure will support both the tribal goals and EPA's policy of tribal self-governance and recognition of sovereignty.

LIBC resolutions 90-88 and 92-43 directed the Water Resources Division of the Lummi Natural Resources Department to develop a comprehensive water resources management program that ensures that the planning and development of Reservation water and land resources are safeguarded against surface and ground water degradation. Reliable information on the quality of the surface and ground water of the Reservation is required in order to effectively manage these resources.

The EPA and other federal agencies have previously supported the Nation's assessment of priority water resource needs and the identification of unmet needs. Environmental planning intended to protect the Nation's water resources has included development of a Wellhead Protection Program (LWRD 1997), a Storm Water Management Program (LWRD 1998), a Wetland Management Program (LWRD 2000), a Non-Point Source Management Program (LWRD 2001, LWRD 2002), and Water Quality Standards for Reservation surface waters (LWRD 2008). These programs are components of the Lummi Nation Comprehensive Water Resources Management Program (CWRMP). Important milestones in the program development effort include the adoption of the Lummi Nation Water Resources Protection Code (Title 17 of the Lummi Code of Laws) during January 2004 and the adoption of surface water quality standards in August 2007. These tribal water quality standards were approved by the EPA in September 2008.

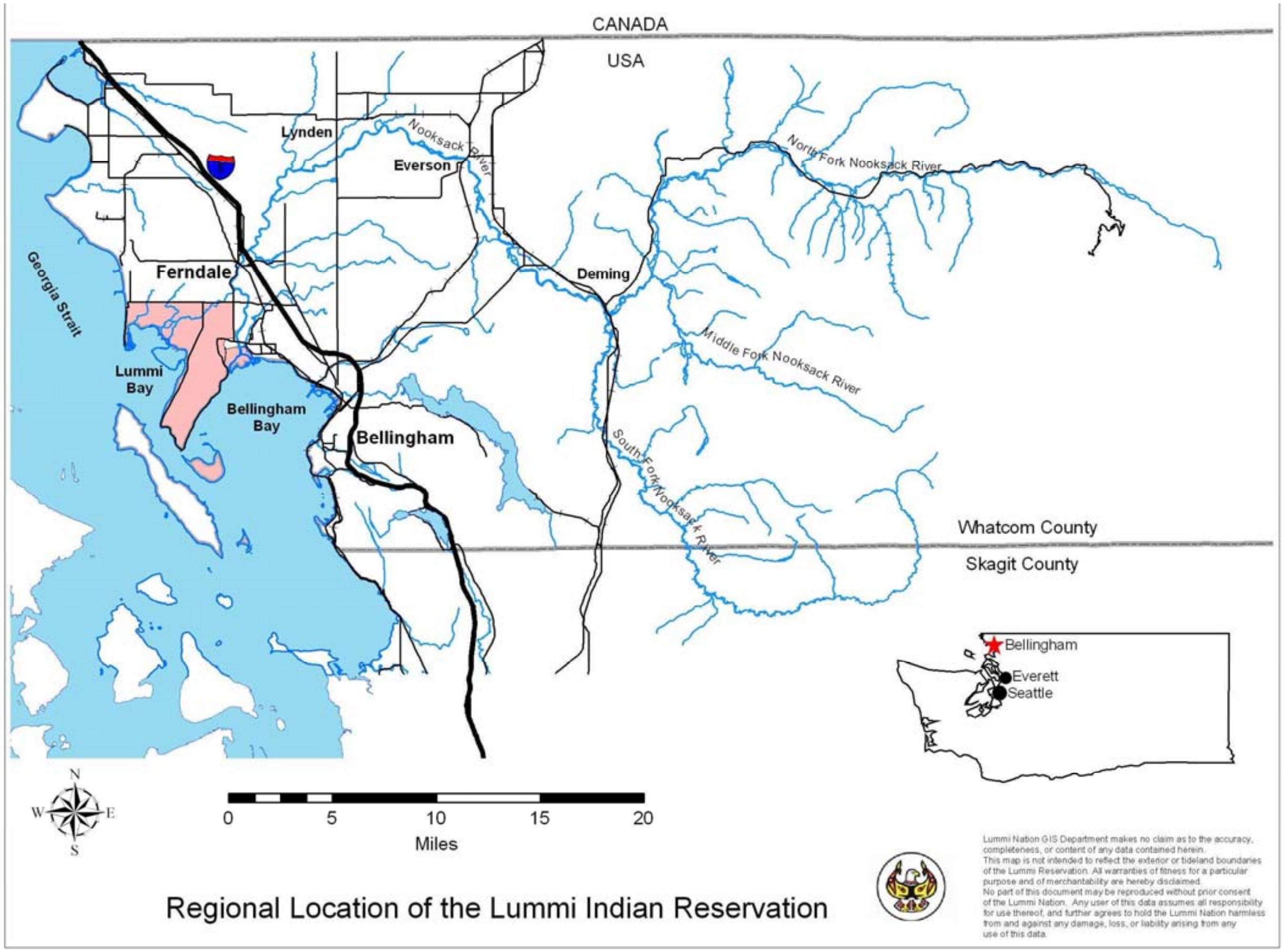

Figure 2.1 Regional Location of the Lummi Indian Reservation

2.3. Lummi Nation Waters

Lummi Nation Waters are all fresh and marine waters that originate or flow in, into, or through the Reservation, or that are stored on the Reservation, whether found on the surface of the earth or underground, and all Lummi Nation tribal reserved water rights (Lummi Code of Laws [LCL] 17.09).

2.3.1. Surface Water

The Lummi Nation is the largest fishing tribe in Puget Sound and has relied on their water resources since time immemorial for ceremonial, subsistence, and commercial purposes. There are 38 miles of marine shoreline surrounding most of the Reservation (except portions of the east boundary and the northern boundary). The surrounding tidelands are in the Strait of Georgia, Lummi Bay, Hale Passage, Portage Bay, and Bellingham Bay. In addition to marine waters, there are approximately 24.4 miles of rivers, streams, sloughs, and drainages on the Reservation including the multiple distributary channels of the Nooksack River delta. There are no lakes on the Reservation, but there are approximately 13 ponds. Finfish and shellfish spawn, incubate, and grow within and adjacent to Lummi Nation Waters. The Lummi Nation also operates one shellfish and two finfish hatcheries on the Reservation.

Eighteen watersheds are found on the Lummi Reservation. Reservation watersheds were delineated by the Lummi Water Resources Division as “A” through “S” (Figure 2.2) and vary in size from 87 acres up to 4,700 acres (LWRD 1998). The Nooksack River discharges to Reservation tidelands, but most of the approximately 786 square mile (503,040 acres) Nooksack River watershed is upstream of the Reservation. The 19 watersheds are aggregated into two primary drainage areas: Lummi Bay and Bellingham Bay (Figure 2.3). The Lummi Bay watershed is comprised of 12 watersheds: C, H, I, J, K, L, M, N, O, P, Q and R. The Bellingham Bay watershed is comprised of 7 watersheds: A, B, D, E, F, G, and S. As shown in Table 2.1, 12 of the 19 watersheds are completely within the Reservation boundary. Approximately 0.1 percent of the Nooksack River watershed (Watershed S) is on the Reservation.

There are eleven defined rivers, streams, sloughs, and drainages in the Lummi Bay and Bellingham Bay watersheds (Figure 2.3). Streams on the Reservation are classified as either Category 1 or Category 2 streams (LCL Title 17.06.080). Category 1 streams are all streams that flow year-round during years of normal rainfall or are used by juvenile or adult salmonids. Category 2 streams are all streams that are intermittent or ephemeral during years of normal rainfall and are not used by juvenile or adult salmonids. Of the eleven defined rivers, streams, sloughs and drainages, there are six Category 1 streams and five Category 2 streams on the Reservation. All other agricultural ditches and unnamed drainages are classified as Category 2 streams. As shown in Table 2.2, there are approximately 24.4 miles of streams, rivers, sloughs, and drainages on the Reservation. Jordan Creek, Lummi River, Smuggler’s Slough, Slater Slough, Schell Creek, Onion Creek, and Seapond Creek are included in the Lummi Bay watershed. The Bellingham Bay watershed is comprised of the Nooksack River, Kwina Slough, Lummi Shore Road streams, and Portage Island streams. Five streams, rivers, sloughs, and drainages are completely within the boundaries of the Reservation.

Prior to approximately 1860, the Nooksack River discharged to Lummi Bay rather than Bellingham Bay (Deardorff 1992, WSDC 1960). The river flow was redirected to Bellingham Bay at that time and currently the Lummi River only receives water from the Nooksack River when the Nooksack River flows exceed approximately 9,600 cubic feet per second (cfs). The Lummi River currently drains much of the area west of the Nooksack River in the vicinity of Ferndale, Washington. The Nooksack River drains most of western Whatcom County, including the forested uplands and the developed lowlands.

The Nooksack River flow is comprised of ground water and precipitation throughout the year supplemented by glacial melt and snowmelt from Mount Baker and adjacent peaks during the summer months. The Nooksack River supports several important species of salmon and other aquatic life. The Nooksack River delta is part of the Reservation and is part of an important marine wetland-estuary complex. There are water quality and water quantity challenges in the Nooksack watershed due to land development and agriculture. Whatcom County, which includes all of the lowlands in the Nooksack River watershed, had 167 dairy operations in 2005. Approximately 220 acres of tribal shellfish beds in Portage Bay were closed from November 1996 to May 2006 due to bacterial contamination attributed to poor dairy nutrient management practices in the Nooksack River watershed (DOH 1997, Ecology 2000).

Nearly all of the water bodies in the Lummi River and Nooksack River floodplains are exposed to marine influences, which include the presence of saline water, salinity-based-stratification (stratification), and upstream flow during high tide. Most of the water quality sample sites are tidally influenced (water level and/or salinity) and have variable water column profiles (e.g., stratified or well-mixed) and salinities. In addition, upland sampling sites become saline or dry during the summer months as the dry season progresses. Once the wet season begins during October or November, flow from the uplands increase, diluting many of the saline monitoring sites with fresh water.

The 1999 comprehensive inventory of wetlands on the Lummi Reservation (LWRD 2000) indicated that approximately 43 percent (5,432 acres) of the Reservation upland areas are either wetlands or wetland complexes (Figure 2.4). Of these Reservation wetlands, about 60 percent are located in the flood plains of the Lummi and Nooksack rivers. Wetland complexes are areas where wetlands form a highly interspersed mosaic with upland hummocks. During the 1999 wetland inventory, boundaries were drawn around the outer edges of the mosaics and the entire areas labeled as “wetland complexes”. As a result, the estimated wetland area identified in the inventory generally represents more wetland area than actually exists. All wetland boundaries mapped during the comprehensive wetland inventory are general boundaries based on soil survey mapping and interpretation of color and infrared aerial photographs with some field verification. More accurate wetland boundaries are being delineated on the ground as needed for specific activities and as part of an overall effort to improve the spatial accuracy of the wetland Geographic Information System (GIS) database. As of 2009, approximately 2,218 acres of wetland areas have been field verified (LWRD 2009).

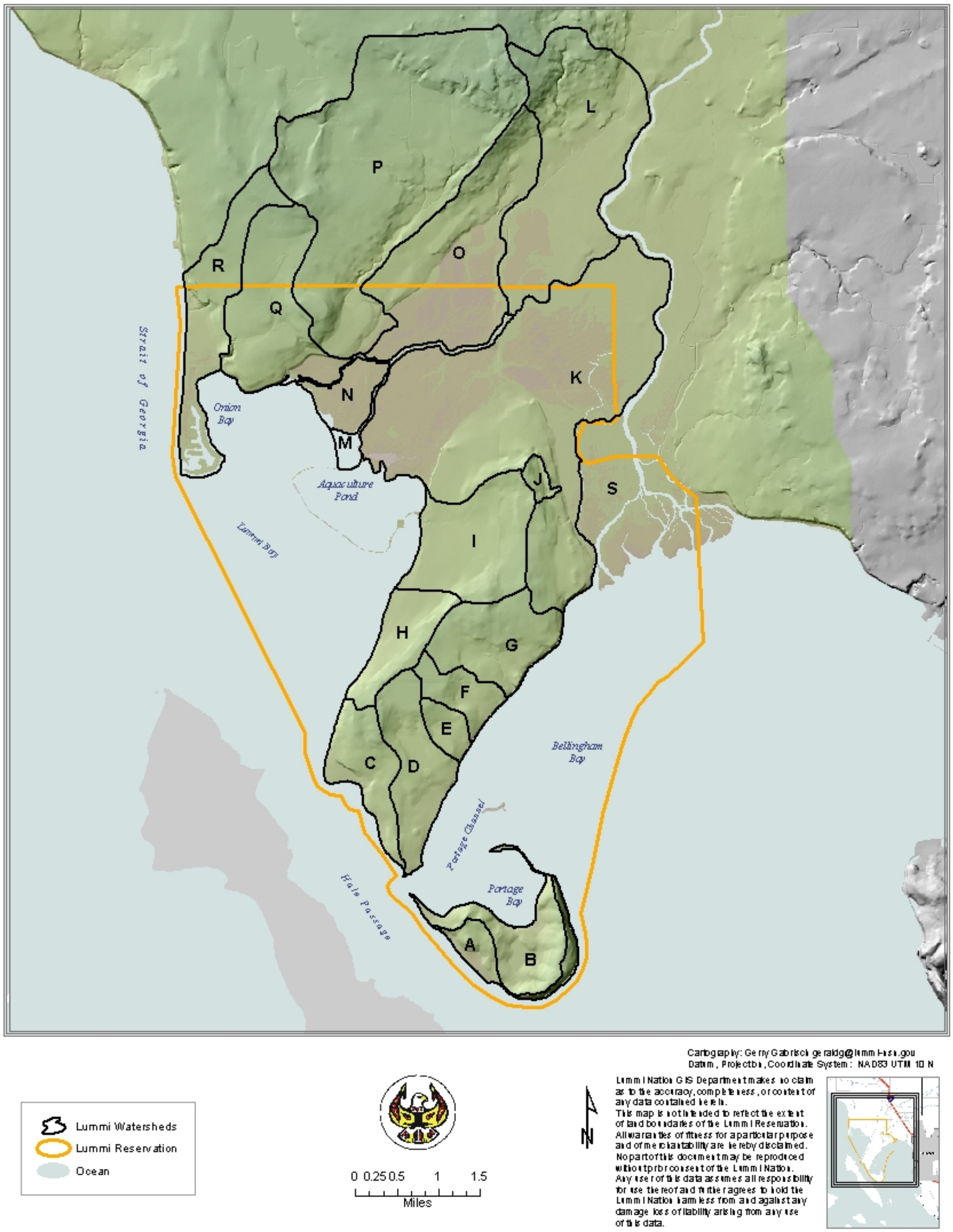

Figure 2.2 Lummi Nation Watersheds

Table 2.1 Acres of Watersheds On-Reservation and Off-Reservation

	Basin ID	Total Watershed Area (acres)	On-Reservation Watershed Area (acres)	Off-Reservation Watershed Area (acres)	On-Reservation Percent of Watershed
Lummi Bay Watershed	C	583	583	0	100
	H	537	537	0	100
	I	1,142	1,142	0	100
	J	87	87	0	100
	K	4,696	3,954	742	84
	M	198	198	0	100
	N	333	333	0	100
	L	2,384	75	2,309	3
	O	1,964	714	1,250	36
	P	4,229	475	3,752	11
	Q	1,292	839	452	65
	R	1,024	602	422	59
Bellingham Bay Watershed	A	307	307	0	100
	B	634	634	0	100
	D	797	797	0	100
	E	183	183	0	100
	F	326	326	0	100
	G	836	836	0	100
	S	515,914	640	515,274	0.1

* Includes the area within Sandy Point Channel and the Lummi River delta which is not classified as uplands

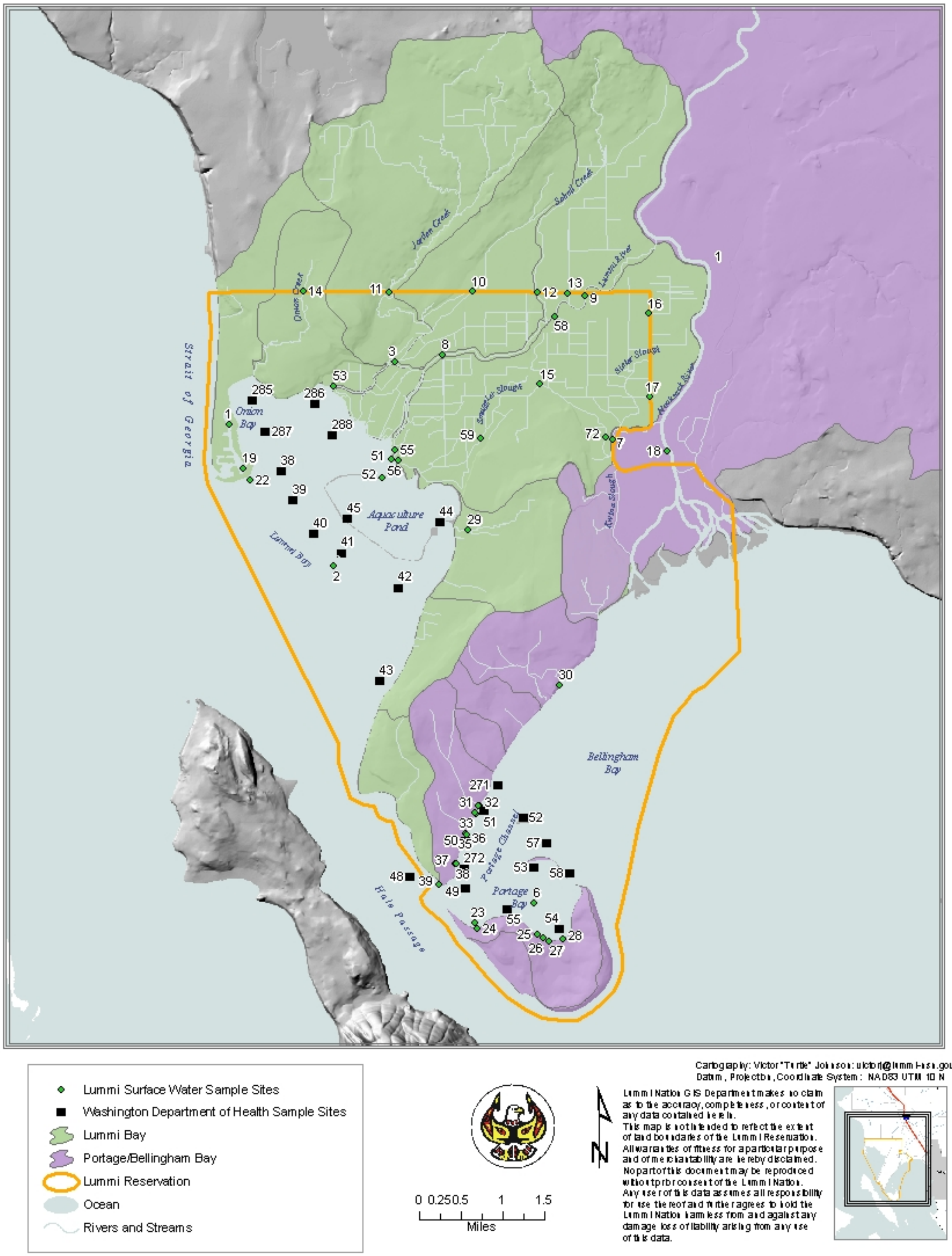

Figure 2.3 Lummi Bay and Bellingham Bay Drainage Areas

Table 2.2 River and Stream Miles On-Reservation and Off-Reservation

	River/ Stream	Stream Category	Total Stream/ River Miles	On-Reservation Stream/ River Miles	Off-Reservation Stream/ River Miles	On-Reservation Percent of Stream/ River Miles
Lummi Bay Watershed	Jordan Creek	1	6.6	2.1	4.5	32
	Lummi River	1	5.0	3.6	1.4	70
	Smuggler's Slough	1	3.9	3.9	0	100
	Slater Slough	2	1.3	1.3	0	100
	Schell Creek	1	4.1	0.4	3.7	10
	Onion Creek	2	2.2	1.8	0.4	81
	Seapond Creek	2	1.7	1.7	0	100
Bellingham Bay Watershed	Nooksack River	1	150	5.1*	144.9	3
	Kwina Slough	1	2.3	2.1	0.2	91
	Lummi Shore Road Streams	2	2.3	2.3	0	100
	Portage Island Streams	2	0.1	0.1	0	100

* Includes all the distributary channel lengths in the Nooksack River delta.

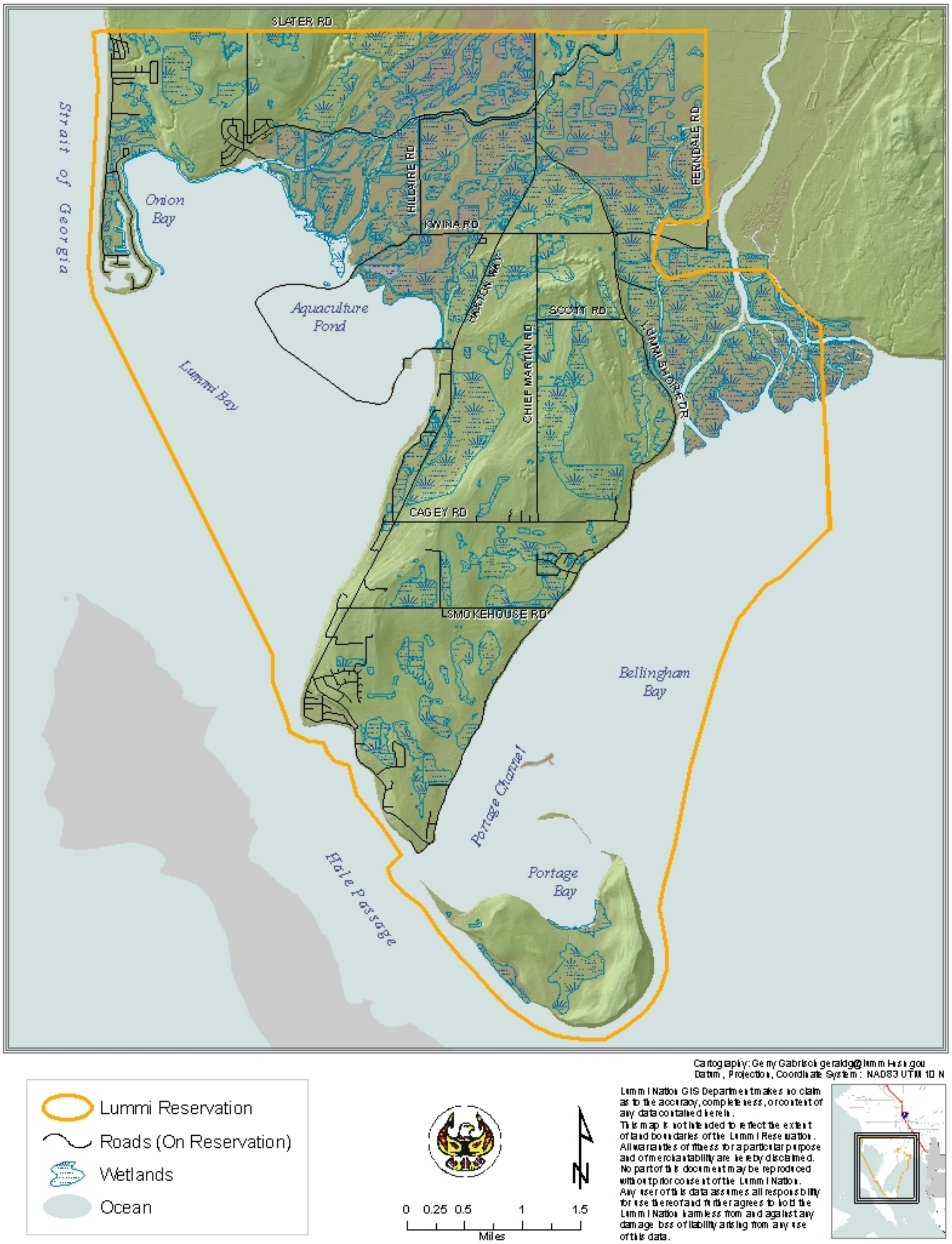

Figure 2.4 Lummi Nation Wetland Locations

2.3.2. Ground Water

Two apparently separate potable ground water systems occur on the Reservation (LWRD 1997). One system is located in the northern upland area (Figure 2.5). This northern system appears to flow onto the Reservation from the north and drains to the west, south, and east. The second potable ground-water system is located in the southern upland area of the Reservation (Lummi Peninsula) and is completely contained within the Reservation boundaries (LWRD 1997). The floodplain of the Lummi and Nooksack rivers, which contains a surface aquifer that is saline (Cline 1974), separates the two potable water systems. A third potable water system may exist on Portage Island, but information on the water quality and the potential yield of this system is limited and inconclusive. Over 95 percent of the potable water used by Reservation residents is pumped from the Reservation aquifers. Because of the proximity to marine waters and the local geology, the aquifers on the Reservation are subject to both horizontal and vertical salt-water intrusion if wells are over-pumped (LWRD 1997).

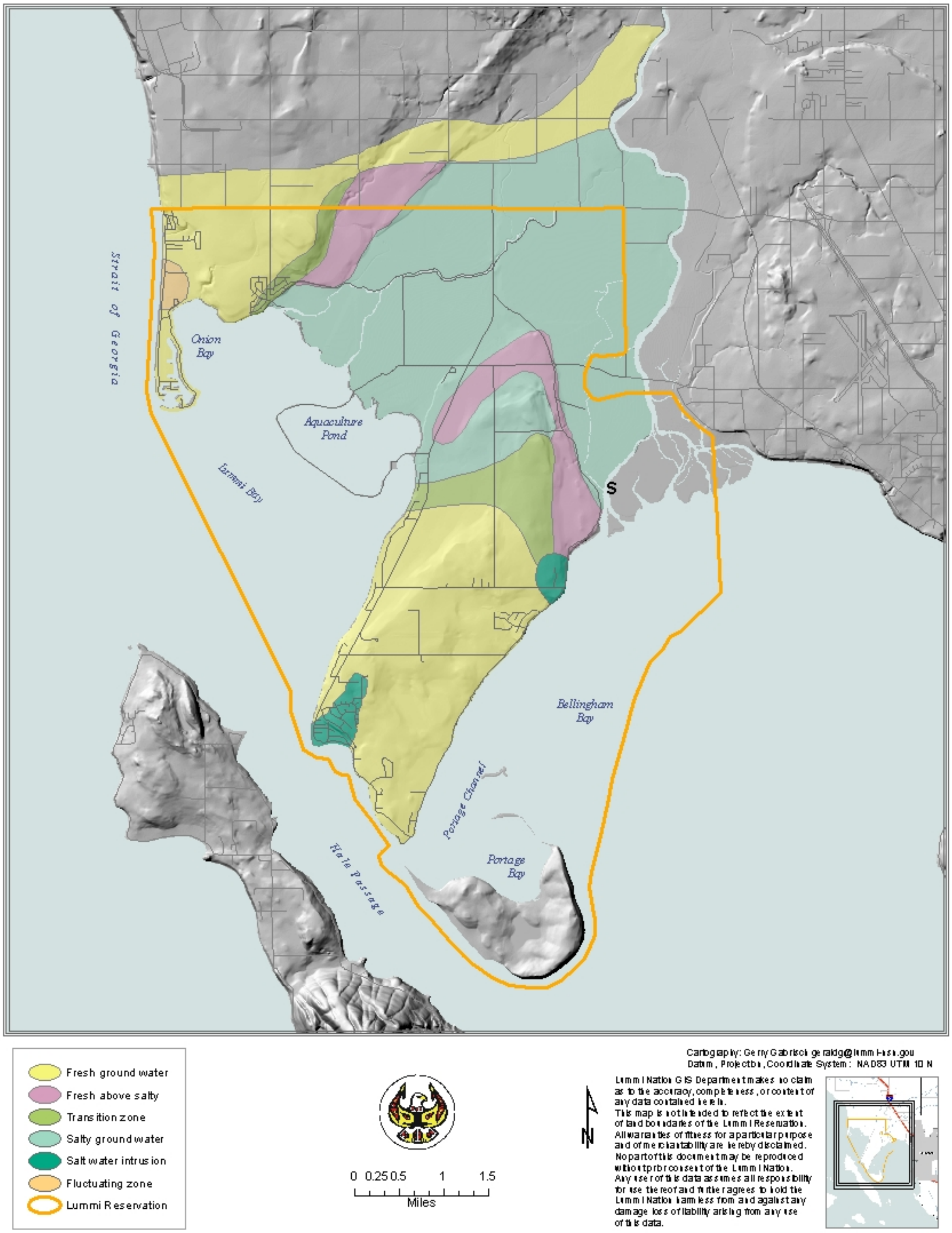

Figure 2.5 Ground Water Characteristics (Cline 1974)

3. WATER QUALITY MONITORING OBJECTIVES

The purpose of this section is to describe the goals of the Lummi Water Resources Division (LWRD), the long-term water quality monitoring objectives, the Surface Water Quality Monitoring Program objectives, and the Ground Water Quality Monitoring Program objectives.

3.1. Lummi Water Resources Division Goals

The LWRD is responsible for protecting, restoring, and managing Lummi Nation water resources, including the Reservation shorelines, in accordance with the policies, priorities, and guidelines of the Lummi Nation. The overall goal of the LWRD is to protect the treaty rights to water of sufficient quantity and quality to support both the purposes of the Reservation as a permanent, economically viable homeland for the Lummi People, and a sustainable harvestable surplus of salmon and shellfish sufficient to support a moderate living standard.

3.2. Long-Term Water Quality Monitoring Objectives

The Lummi Nation Surface and Ground Water Quality Monitoring Program (Program) has been ongoing since 1993. The goal of the Program is threefold: (1) to establish the baseline conditions of surface and ground waters on and flowing onto the Reservation, (2) to use this information to evaluate regulatory compliance of waters flowing onto the Reservation, and (3) to support the development and implementation of a water quality regulatory program on the Reservation.

The water quality monitoring objectives to help achieve the overall LWRD and the Program goals include:

1. Monitor surface and ground water quality at representative locations and at frequencies sufficient to establish baseline conditions of Lummi Nation Waters.
2. Monitor surface waters for compliance with the Lummi Nation surface water quality standards to support all beneficial uses, including public health and public enjoyment; the propagation, protection, and restoration of fish, shellfish, wildlife, and their habitats; and the protection of the surface waters of the Lummi Indian Reservation as cultural, economic, and spiritual resources of the Lummi People.
3. Identify and evaluate on- and off-Reservation sources of fecal coliform bacteria contributions to shellfish harvest areas.
4. Detect and document threats to water quality and associated beneficial uses to support compliance actions.
5. Protect ground water supplies from saltwater intrusion and ground water mining.

3.3. Surface Water Quality Monitoring Program Objectives

The Lummi Nation Nonpoint Source Assessment Report (LWRD 2001), the Lummi Nation Nonpoint Source Management Plan (LWRD 2002), and other documents developed as part of the Lummi Nation Comprehensive Water Resources Management Program (LWRD 1997, LWRD 1998, LWRD 2000) identify and locate the numerous threats to the quality of Lummi Nation Waters. These threats include both point and nonpoint sources of pollution and other threats associated with various land uses.

Threats to Lummi Nation Waters include contamination of surface waters from on- and off-Reservation sources that could damage resource rich Reservation tidelands, or adversely impact fisheries (e.g., closure of shellfish beds harvested for ceremonial, subsistence, and/or commercial purposes). Although all on-Reservation tribal shellfish beds have been reopened to commercial harvest since May 2006, on-Reservation commercial shellfish beds were downgraded from “approved” to “restricted” for extended periods of time since 1996. The cause of the downgrades was attributed to contaminated Nooksack River water entering Portage Bay (DOH 1997, Ecology 2000).

The purpose of the surface water quality-monitoring component of the Program, which is presented in this report, is to establish the baseline conditions of waters on and flowing onto the Reservation, to detect water quality problems, and to help identify the pollutant sources. Information from the Program is used to:

- Evaluate compliance of waters flowing onto and within the Reservation with water quality criteria,
- Evaluate fecal coliform bacteria contributions from on- and off-Reservation to shellfish harvest areas, and
- Support the development and implementation of a water quality regulatory program on the Reservation, including the creation, adoption, implementation, and revision of Lummi Nation Water Quality Standards.

3.4. Ground Water Quality Monitoring Program Objectives

The purpose of the ground water quality monitoring component of the Program is to protect ground water supplies from saltwater intrusion and ground water mining. Ground water resources on the Reservation are vulnerable to salt water intrusion due to the proximity of marine waters and local geology (LWRD 1997). The majority of residential development to date has occurred along the marine shorelines of the Reservation placing the most vulnerable portion of aquifers at risk through direct pumping of ground water near marine waters. Protection of ground water is essential because:

- Over 95 percent of all water consumed on the Reservation comes from ground water.
- An ample supply of good quality ground water is needed to serve the purposes of the Reservation as a permanent and economically viable homeland for the Lummi People.

4. SURFACE AND GROUND WATER QUALITY ASSESSMENT METHODS

The purpose of this section of the report is to summarize the approach used to establish the ambient quality conditions of Reservation surface and ground water and to summarize the field data collection and laboratory analysis methodologies detailed in the *Lummi Nation Water Quality Monitoring Program Quality Assurance/Quality Control Plan – Version 3.0* (LWRD 2006a).

4.1. Overview of Surface and Ground Water Assessment Design

The LWRD employs both a fixed station network and a targeted water sampling design. The fixed station network is used for baseline water quality monitoring and includes 43 routine surface water sites and 28 ground water sites (LWRD 2006a). In addition to these 43 surface water quality sample sites, the LWRD also collects samples at 6 Washington Department of Health (DOH) sample sites within Lummi Bay. As described in Section 4.2, the DOH collects water quality samples from Portage Bay. A targeted sampling design approach is used to improve understanding of specific issues that warrant further investigation (e.g., a reported or observed manure spill, a fish or waterfowl kill near a pesticide application site, questions regarding water quality impacts of an automobile recycling facility, storm water discharge from a construction site). For a targeted design approach, sites from the fixed station monitoring network and other sites located both up- and down-stream from the identified potential pollutant source is sampled.

4.2. Surface Water Field Data Collection and Laboratory Analysis

Since 1993, the Program has grown significantly in the number of sites sampled, the parameters measured, and the ability to manage and analyze collected data. Additional sites were added in the late 1990s to better evaluate the water quality impacts from the Nooksack River water on Portage Bay and to better evaluate conditions in the Lummi Bay watershed. Figure 4.1 shows the locations of the current LWRD water quality sampling sites on the Reservation. Figure 4.2 displays the DOH sample sites in Portage Bay. Overall, there are approximately 24.4 miles of rivers, streams, sloughs, and drainages on Reservation. Many of the 43 sample sites are located at the Reservation border, with the majority of the contributing watershed located off-Reservation. In addition, several intermittent streams and storm water systems are sampled as part of the Program, as well as the marine waters of Lummi Bay, Portage Bay, and the Sandy Point Marina.

In consultation with the Lummi Nation and under the Shellfish Consent Decree (Order Regarding Shellfish Sanitation, *United States v. Washington [Shellfish]*, Civil Number 9213, Subproceeding 89-3, Western District of Washington, 1994), the Washington Department of Health (DOH) is responsible to the federal Food and Drug Administration (FDA) to ensure that the National Shellfish Sanitation Program (NSSP) standards for certification of shellfish growing waters are met on the Reservation. In Lummi Bay six additional sample sites are sampled to provide logistical assistance to the DOH and also to assist with the achievement of Program goals. The DOH samples 12 sites in Portage Bay six times a year, which assists in achievement of program goals.

Thirty-two (32) of the 43 Lummi sampling sites are accessible from land. As summarized in Table 4.1 and Table 4.2, the LWRD staff measure a range of water quality variables each month. During the late summer to early-winter period, "first flush" sampling is conducted at many of these sample sites at variable intervals (daily to weekly) based upon precipitation and runoff levels during the onset of the wet season.

The remaining 11 surface water quality sample sites are accessible by boat and are located on Portage Island, in southern Portage Bay, in Lummi Bay, and in the Sandy Point Marina. These sample sites are targeted for monthly sampling, but unsafe weather conditions have historically reduced the sample frequency. A larger sampling boat was put into service during 2007 to allow for safe sampling during poor weather conditions. The DOH sites in northern Lummi Bay are sampled at least six times each year by LWRD staff in coordination with the DOH.

Information from all sample runs is used to establish baseline conditions, identify trends, and to evaluate compliance with water quality criteria. Some runs serve other purposes as well, for example, to determine if sources of fecal coliform bacteria in Portage Bay are local or from the Nooksack River watershed. To make this determination, the data collected by the DOH in and around Portage Bay are analyzed in conjunction with the data collected as part of the "Lummi Shore Road" (LSR) sample run and the "Portage Bay DOH Support" sample run. The LSR sample run is scheduled to occur within a few hours prior to the DOH sampling of Portage Bay. At the latest, the sampling occurs concurrently with DOH sampling of Portage Bay. Similar to the LSR sample run, the data collected as part of the "Bellingham Bay Watershed First Flush" aid in determining fecal coliform bacteria sources impacting the Portage Bay shellfish beds.

The data collected under the "Floodplain East" (FPE) and "Floodplain West" (FPW) sample runs are used to establish baseline conditions for waters flowing onto the Reservation and through to Lummi Bay (all within the Lummi Reservation). Similar to the LSR sample run, the data collected as part of the FPE, FPW, and Lummi Bay First Flush sample runs aid in determining fecal coliform bacteria sources that may affect the Lummi Bay shellfish beds.

The collection of water quality data along the Reservation boundary allows for compliance evaluation of waters flowing onto the Reservation by comparing the sample results with water quality criteria. The sample site selection also allows surface water quality to be evaluated along the length of the Lummi River floodplain water bodies and their tributaries. This water quality information is used to help identify pollution sources in the Lummi Bay Watershed.

Data collected as part of the boat-accessible sample run are used to establish baseline conditions of water quality in the Sandy Point Marina, Lummi Bay, Portage Bay, and the five

Portage Island fresh water discharges to Portage Bay. These data can also help identify sources of pollution.

The Lummi Bay DOH Support sample run is conducted to provide information about water quality in the northern portion of Lummi Bay and assists in evaluating downstream impacts of elevated fecal coliform bacteria levels measured along the Reservation boundary.

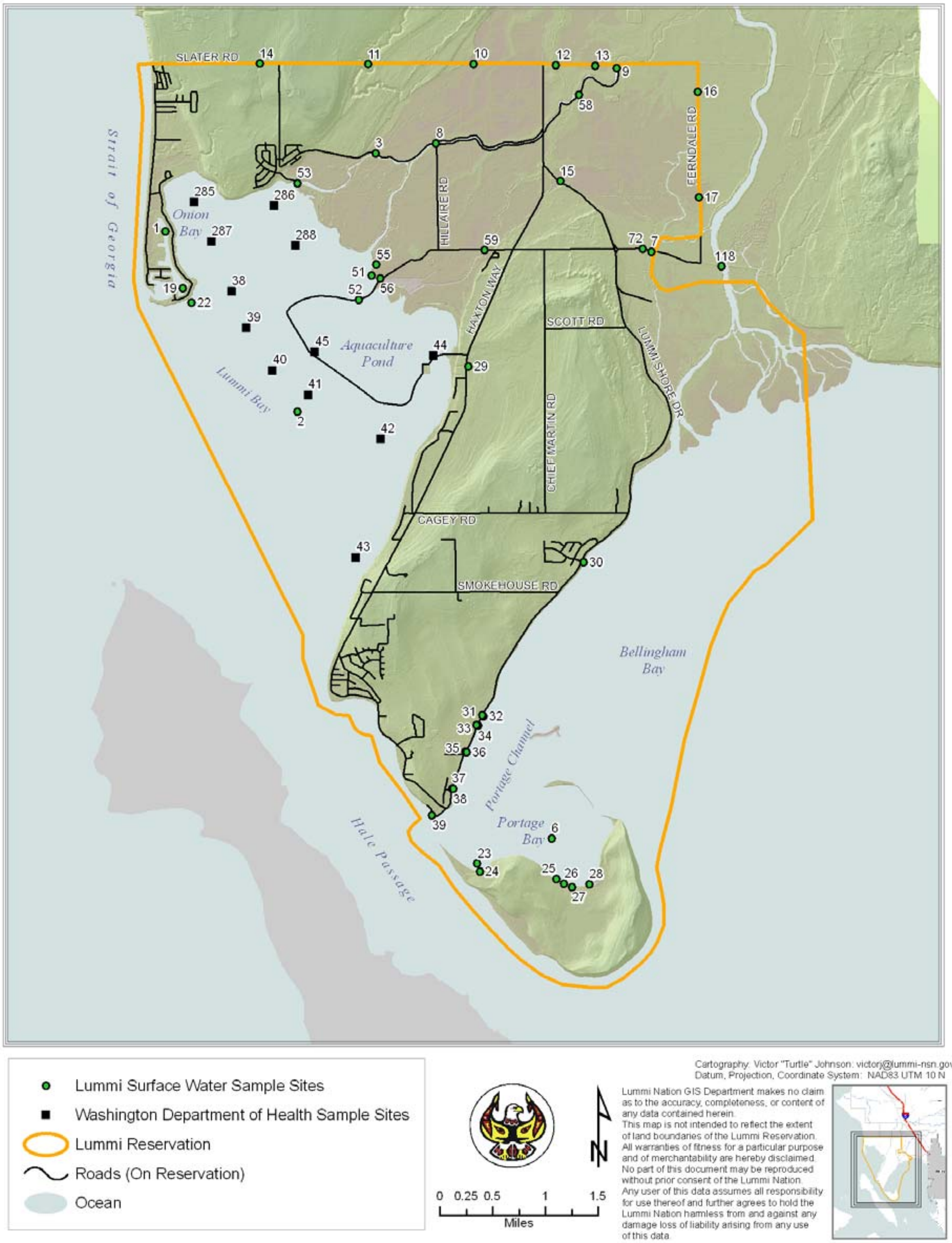

Figure 4.1 Surface Water Quality Monitoring Program Sample Site Locations

Figure 4.2 Washington Department of Health Water Sample Sites in Portage Bay

The primary change in parameters measured over the Program period of record was the addition of new laboratory analyses. Bacteria sampling expanded in 2000 from often enumerating only one type of bacteria, fecal coliform or *Escherichia coli* (*E. coli*), to consistently enumerating both of these bacteria plus enterococci. In addition, starting in 1999 a suite of nutrient samples was collected approximately four times per year at five sites, and several metals are sampled four times per year at two sites. When the Program was initiated in 1993, no nutrient or metal analyses were performed. At selected sites, discharge is measured to allow for loading calculations, and sampling is increased from the regular once-per-month to more frequent sampling during "first flush" events.

The conventional parameters measured over the Program period of record have remained constant, with the exception of pH and turbidity. The pH was not measured for many years (except at the contract laboratory for nutrient and metal samples) and, although total suspended solids are measured at the five sites that are sampled for nutrients, turbidity was not measured consistently prior to 2008. These parameters were not measured because of equipment problems coupled with the staff constraints described in Section 1.4. Starting in 2007, pH analysis was included for all sampling events, even if in some cases pH results were not obtained because of equipment malfunctions. Since March 2008, monthly turbidity measurements have been collected at the sample sites. Flow was not measured regularly at each site during 2009 due to time constraints.

Table 4.1 summarizes the surface water quality monitoring sampling schedule for the following parameters measured during 2009 (see Appendix A): water temperature, air temperature, water depth, specific conductivity, salinity, dissolved oxygen, pH, fecal coliform bacteria, *E. coli*, and enterococci. In accordance with the quality assurance plan for the laboratory, the contracted independent laboratory measures all bacteria from the same sample bottle, and fecal coliform bacteria and *E. coli* are measured from the same culture.

Table 4.2 shows the specific nutrients, metals, and hydrocarbons analyzed at independent state- or federally-certified laboratories. Due to the costs of analyzing water quality samples for metals and petroleum hydrocarbons, these parameters are only measured quarterly at two of the water quality monitoring sites (one fresh water site downstream from a petroleum oil refinery and one marine water site within a recreational boat marina). Similarly, due to cost considerations, nutrients are measured quarterly at only five of the surface water quality monitoring sites. Depending on the specific intent of the sampling effort, nutrients analyzed ranged from ammonia, nitrate, and total phosphorus for "first flush" sample runs during the onset of the rainy season, to the same five parameters plus 5-day biochemical oxygen demand (BOD), nitrite, Total Kjeldahl Nitrogen (TKN), orthophosphate, total organic carbon, total suspended solids, total volatile suspended solids, alkalinity, pH, sulfate, sulfide, chlorophyll *a*, iron, and silicon. Metals analyzed include lead, zinc, copper, and chromium at Site SW001 and Site SW014. The Site SW001 location is near the Sandy Point Marina and the Site SW014 location is along the stream that drains from the Conoco-Phillips petroleum oil refinery located along the western extent of the northern Reservation boundary. At both of these sites, pH and petroleum hydrocarbons are also measured. During 2009 sampling season, only one nutrient sample was collected due to time and resource constraints.

The major change in data collection during 2009 was the addition of continuous temperature data loggers at 10 surface water quality sites throughout the Reservation starting in August 2009. A temperature measurement is recorded every 15 minutes at each site. The temperature data are downloaded on a monthly basis. Beginning in 2010, the collected data will be used to calculate the 7-day average of the daily maximum for fresh water sites and the 1-day maximum temperature for marine water sites, which will allow for a direct comparison with the applicable water quality standards. In addition, during the summer 2010, a comprehensive habitat characterization of all sample sites will be completed. Currently, the habitat at each site has been described in general terms in previous annual water quality summary reports. A more intensive evaluation of sample site habitat will assist in identifying locations on the Reservation that need restoration efforts to improve water quality.

The quality assurance protocols identified in the *Lummi Nation Water Quality Monitoring Program Quality Assurance/Quality Control Plan – Version 3.0* (LWRD 2006a) was followed for the sample collection in 2009. The quality assurance review of the data over the 1993 through 2009 period has not been completed, and as a result, all data presented in this report for this period are considered as “Preliminary, Subject to Revision.” The data collected during 2009 are provided in Appendix A and will be exported to WQX during the second quarter of the 2010 calendar year.

Table 4.1 Surface Water Quality Monitoring Sites

Run Name	Sample Sites(s) Included	Conventional Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Measurement Frequency	Notes
Floodplain East (FPE)	15, 16, 17, 51, 52, 55, 56, 59, 72, 118	Air temperature, salinity-based stratification, water temp., salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly	Site 118 along the Nooksack River is measured in all surface water sample runs, providing information on a known pollutant source to Portage Bay. Site 51 is measured in both the FPE and FPW runs. Flow is only measured when appropriate channel conditions are present.
Floodplain West (FPW)	3, 8, 9, 10, 11, 12, 13, 14, 51, 53 58, 118	Air temperature, salinity-based stratification, water temp., salinity, specific conductivity, current/flow direction, DO, flow, pH, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly	Site 118 along the Nooksack River is measured in all surface water sample runs, providing information on a known pollutant source to Portage Bay. Site 51 is measured in both the FPE and FPW runs. Flow is only measured when appropriate channel conditions are present.
Lummi Shore Road (LSR)	7, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 118	Air temperature, salinity-based stratification, water temp., salinity, specific conductivity, current/flow direction, DO, flow, pH, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly in coordination with the DOH sampling of Portage Bay Sites along Lummi Shore Road sampled from north to south or from south to north	Occasionally Site 118 is sampled at beginning and end of run if Portage Bay sampling occurs late in the morning or afternoon. Flow is only measured at upland sites along the Portage Bay and Bellingham Bay shorelines.

Table 4.1 Surface Water Quality Monitoring Sites

Run Name	Sample Sites(s) Included	Conventional Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Measurement Frequency	Notes
Marine Boat-Accessible (Marine)	1, 2, 6, 19, 22, 23, 24, 25, 26, 27, 28	Salinity-based stratification, water temp., salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, Secchi depth, water/level depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Monthly, as needed	Measure flow at the Portage Island sites (Sites numbered 24 through 28) when channel and flow conditions are appropriate.
Lummi Bay DOH Support	DOH 285, DOH 286, DOH 287, DOH 288, DOH 38, DOH 39, DOH 40, DOH 41, DOH 42, DOH 43, DOH 44, DOH 45	Salinity-based stratification, water temp., salinity, specific conductivity, current/flow direction, DO, flow, pH, Secchi depth, water level/depth, turbidity, and general observations	Fecal coliforms	Six times annually	Washington Department of Health (DOH) provides sample bottles and bacteria enumeration. Logistical difficulties prevent DOH staff from sampling Lummi Bay: tidal window for access to marine sample sites in Portage and Lummi bays is narrow, particularly in the summer (+8.5 ft MLLW tide minimum is required). LNR staff collects bacteria samples and measures other water quality for comparison with water quality standards.
Portage Bay DOH Support	118	Air temperature, salinity-based stratification, water temp., salinity, specific cond., current/flow direction, DO, pH, water level/depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	Three times in one day the day before LSR sample run and DOH sampling of Portage Bay	

Table 4.1 Surface Water Quality Monitoring Sites

Run Name	Sample Sites(s) Included	Conventional Parameters Measured At Each Sample Site	Laboratory Samples Collected At Each Sample Site	Measurement Frequency	Notes
Lummi Bay Watershed First Flush	11, 10, 12, 13, 9, 58, 8, 3, 53, 51, 118 Time permitting: 14, 59, 15, 16, and 17	Salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, water level/depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	As needed based upon predicted and observed runoff during the onset of the rainy season	Site 118 along the Nooksack River is measured in all surface water sample runs, providing information on a known pollutant source to Portage Bay. Site 51 is measured in both the FPE and FPW runs. Flow is only measured when appropriate channel conditions are present.
Bellingham Bay Watershed First Flush	7, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 118	Salinity-based stratification, water temperature, salinity, specific conductivity, current/flow direction, dissolved oxygen (DO), flow, pH, water level/depth, turbidity, and general observations	Fecal coliforms, *E. coli*, and enterococcus	The day following the Lummi Bay First Flush sample run	Sites along Lummi Shore Road sampled from north to south or from south to north. Flow is only measured at upland sites along the Portage Bay and Bellingham Bay shorelines. Site 29 samples a relatively undeveloped Lummi Peninsula upland watershed and is used as a control site representing a watershed that is minimally affected by development.

Table 4.2 Parameters Measured Quarterly at Selected Sites

Sample Site Number(s)	Group Name	Parameters	Frequency of Collection	Notes
1	Hydrocarbons	Diesel and Lube Oil range hydrocarbons	Quarterly, (depending on the year)	Sample collected in 1-L glass amber bottle. (Monday through Thursday only)
	Metals	Arsenic, Copper, Mercury, Tin, Zinc, Hardness, and pH with the temperature of the water sample at the time of measurement	Quarterly, depending on the year	Sample collected in 1-L plastic bottle. (Monday through Thursday only)
2, 3, 6, 9, 15	Nutrients	Alkalinity, Ammonia, Biochemical Oxygen Demand, Nitrate-N, Nitrite-N, Total Kjeldahl Nitrogen, Ortho Phosphate, Total Phosphorus, pH [with temperature at time of reading], Total Organic Carbon, Total Suspended Solids, Total Volatile Suspended Solids, and may include Iron, Sulfate, Chlorophyll *a*, Sulfide, Silicon and Chemical Oxygen Demand	Quarterly, (depending on the year)	Samples collected in 3 1-L plastic bottles (4 1-L plastic bottles for marine samples) and 2 40-mL amber vials with a preservative. Nitrite and Nitrate are normally combined. (Monday through Thursday only)
14	Hydrocarbons	Diesel and Lube Oil range hydrocarbons	Quarterly and First Flush (depending on the year)	Sample collected in 1-L glass amber bottle. (Monday through Thursday only)
	Metals	Chromium, Copper, Lead, Zinc, Hardness and pH with the temperature of the water sample at the time of measurement	Quarterly and First Flush (depending on the year)	Sample collected in 1-L plastic bottle. (Monday through Thursday only)

4.3. Ground Water Field Data Collection

Twenty-eight sample sites (Figure 4.3) were selected for regular monitoring to characterize the two major potable aquifer systems on the Reservation. Table 4.3 lists the well sampling groups, wells in each group, well number, parameters measured, and measurement frequency. The number of wells sampled has increased over the years but the parameters measured have not changed, other than the addition of pH and salinity measurement. Wells were added as they were drilled or when access was granted to obtain better spatial resolution of aquifer conditions. Water level, pumping status, temperature, specific conductivity, pH, salinity, and chloride concentration are measured monthly or more frequently at each site. Well production is recorded from existing meters at the Lummi Water District water supply wells. If a well is not sampled when scheduled, the well is sampled as soon as possible afterwards.

Sample sites were selected to represent aquifer-wide conditions as practicable, but the spatial representativeness of these sampling points is limited by the lack of existing ground water wells in some parts of the Reservation – particularly along the interior of the Lummi Peninsula and the eastern part of the northwestern upland.

The primary sources of variability are seasonal changes (i.e., wet season and dry season) and pumping regimes (which are typically related to season). This variability is addressed through frequent sampling (sub-monthly to monthly), performing multiple well water level measurements during sampling at each well, and recording the pumping rate, totalizer values (if metered), and pump status of the well at the time of measurement. Water quality is generally stable in the wells.

The chloride concentration, pumping rate and amounts, and water levels of the water supply wells provide critical information about aquifer condition, pumping regimes, and the need for protective measures as these data indicate whether seawater intrusion is occurring or if the likelihood of seawater intrusion has increased. For wells that are not used for water supply purposes (e.g., inactive wells), water level provides information about aquifer conditions.

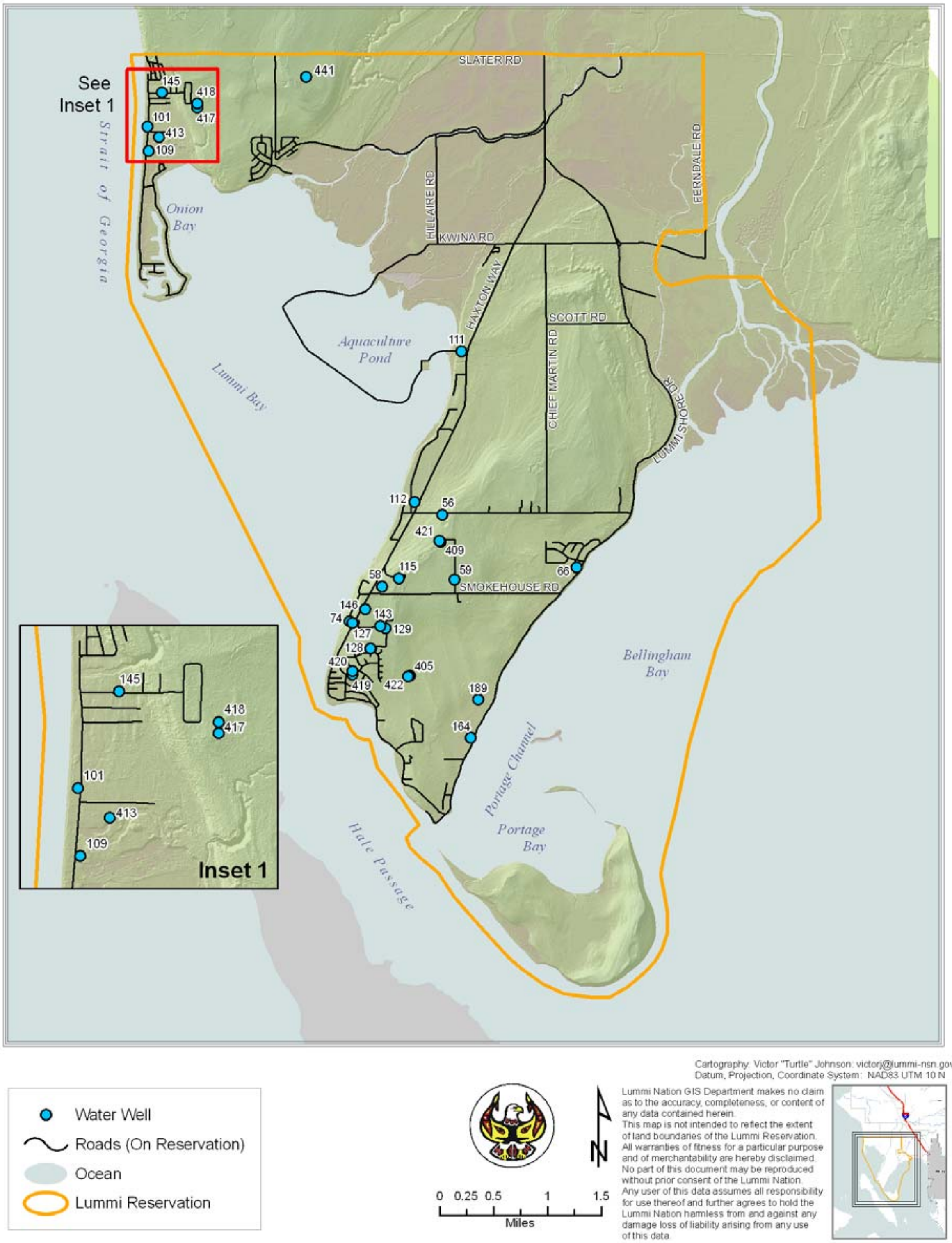

Figure 4.3 Ground Water Quality Monitoring Sample Site Locations

Table 4.3 Ground Water Quality Monitoring Wells

Well Group	Wells	Well Number	Parameters Measured At Each Sample Site	Measurement Frequency
Domestic	R. Jefferson	112	Water level	Monthly
	K. Charles	74	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	Berg	143	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	Bewley	164	Water level	Monthly
	M. Egawa	189	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	J. Finkbonner	109	Chloride, temperature, specific conductivity, pH, salinity, water level infrequently	Monthly
	T. Teeter	413	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
	Skolrood	101	Water level, chloride, temperature, specific conductivity, pH, salinity	Monthly
Potable Public Water Supply Wells	Balch	115	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Horizon	58	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Kinley Way (Kinley 1)	59	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Kinley 2	409	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Kinley 3	421	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Mackenzie 2	129	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Northwest Well 2 (NW2)	418	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	West Shore	146	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Gooseberry Point 4	420	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed
	Gooseberry Point 5	419	Water level, water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed

Table 4.3 Ground Water Quality Monitoring Wells

Well Group	Wells	Well Number	Parameters Measured At Each Sample Site	Measurement Frequency
Monitoring Wells	Hopkins	111	Water level, datalogger upload	Monthly
	Cultee	56	Water level, datalogger upload	Monthly
	Revey	127	Water level, datalogger upload	Monthly
	Mackenzie 1	128	Water level, datalogger upload	Monthly
	Mackenzie 3	405	Water level, datalogger upload	Monthly
	Mackenzie 4	422	Water level	Monthly
	Pierre	66	Water level, datalogger upload	Monthly
	Northwest Well 1 (NW1)	417	Water level, datalogger upload	Monthly
Other Wells	Johnson	145	Water level, datalogger upload, water use, chloride, temperature, specific conductivity, pH, salinity, tank level, and discharge from manifold in tank Flow rate and totalizer at all meters except M. Finkbonner (Nau) and Greg Finkbonner meters every visit to Johnson well. The latter two meters are measured monthly	Weekly or more frequently for water quality, water level, and water use
	Northwest Well 3 (NW3)	441	Water use, chloride, temperature, specific conductivity, pH, salinity	Monthly, or more as needed

(This page intentionally left blank)

5. LUMMI NATION SURFACE WATER QUALITY STANDARDS

The purpose of this section of the report is to summarize the Lummi Nation Surface Water Quality Standards (LWRD 2008). The Water Quality Standards (WQS) for Surface Waters of the Lummi Indian Reservation were adopted by the Lummi Nation in August 2007 and approved by the EPA on September 30, 2008; they are summarized in Table 5.1. Figure 5.1 shows the surface waters of the Lummi Nation, water body classifications for the surface waters, and the current sampling locations.

Because of the Reservation location in the Nooksack River and Lummi River estuaries, many Reservation water bodies are seasonally brackish. This temporal and spatial variability creates uncertainty regarding whether or not marine or fresh water standards apply. To remove this uncertainty, the approach taken in developing the water quality standards for the surface waters of the Reservation was to identify specific geographic locations as the demarcation between fresh and marine waters. These locations are depicted in Figure 5.1. A line between Fish Point and Treaty Rock separates fresh water and marine water in the Nooksack River Delta. The location where the water body flows under Hillaire Road separates the fresh water and marine water in the Lummi River Delta.

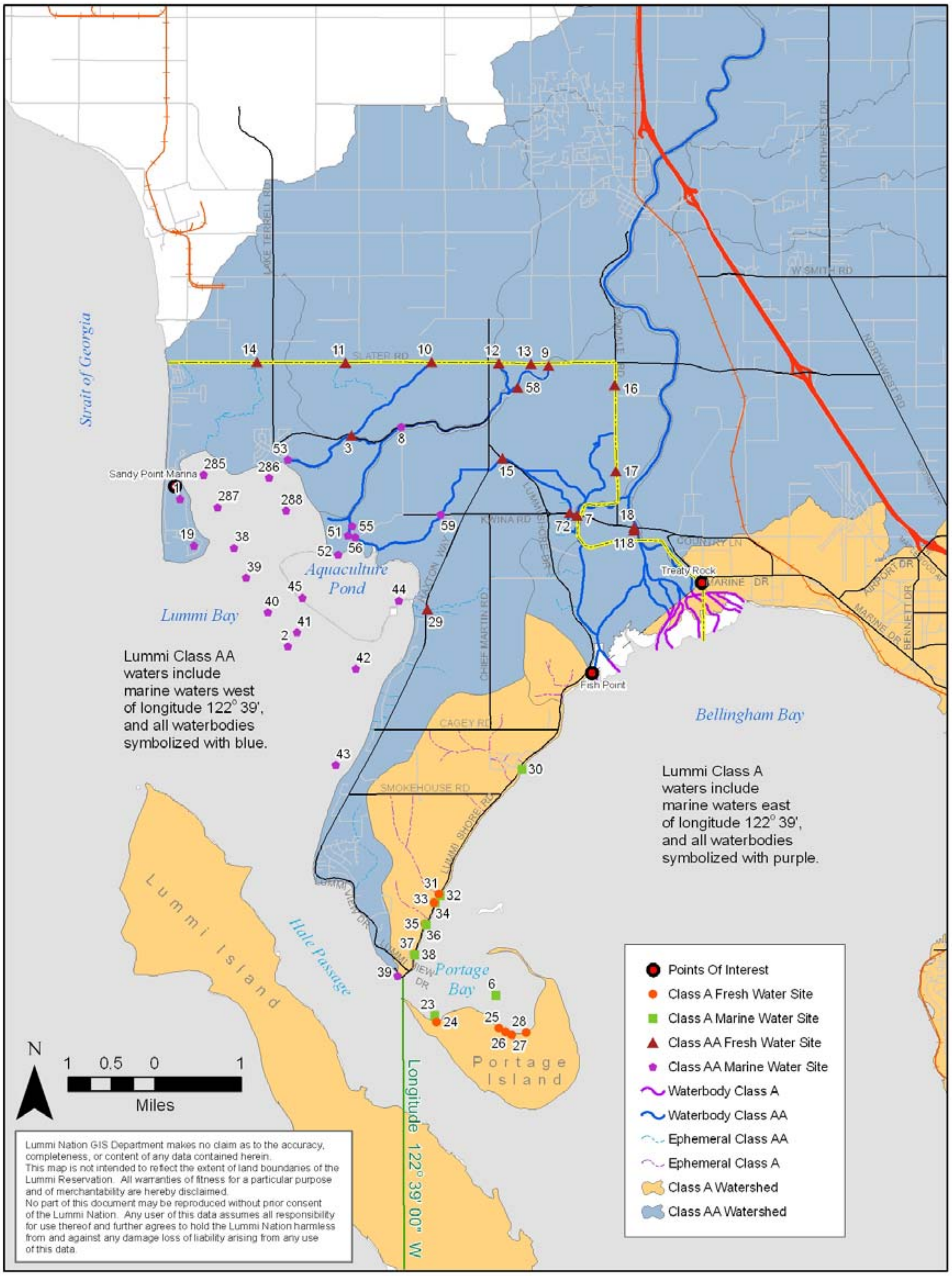

Figure 5.1 Classification of Lummi Nation Waters and Current Sampling Locations

Table 5.1 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Parameter	Surface Water Classes of the Lummi Indian Reservation			
	Class AA Extraordinary	**Class A Excellent**	**Class B Good**	**Lake Class**
General Characteristics	Uniformly exceeds the requirements for all or substantially all uses	Meets or exceeds the requirements for all or substantially all uses	Meets or exceeds the requirements for most uses	Meets or exceeds the requirements for all or substantially all uses

Table 5.1 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

	Surface Water Classes of the Lummi Indian Reservation			
Parameter	**Class AA Extraordinary**	**Class A Excellent**	**Class B Good**	**Lake Class**
Characteristic Uses	**(A)** Water supply (domestic, commercial, municipal, industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam, oyster, and mussel rearing, spawning, and harvesting. Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, geoduck, etc.) rearing, spawning, and harvesting. **(D)** Wildlife habitat. **(E)** Recreation (extraordinary primary contact, primary contact, sport fishing, boating, canoeing, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural	**(A)** Water supply (domestic, commercial, municipal, industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam, oyster, and mussel rearing, spawning, and harvesting. Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, geoduck, etc.) rearing, spawning, and harvesting. **(D)** Wildlife habitat. **(E)** Recreation (primary contact, sport fishing, boating, canoeing, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural	**(A)** Water supply (industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam, oyster, and mussel rearing and spawning. Crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, geoduck, etc.) rearing and spawning. **(D)** Wildlife habitat. **(E)** Recreation (secondary contact, sport fishing, boating, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural	**(A)** Water supply (domestic, commercial, municipal, industrial, agricultural). **(B)** Stock watering. **(C)** Fish and shellfish: Salmonid migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Other fish migration, juvenile rearing, spawning, egg incubation, fry emergence, and harvesting. Clam and mussel rearing and spawning. Crayfish rearing and spawning. **(D)** Wildlife habitat. **(E)** Recreation (extraordinary primary contact, primary contact, sport fishing, boating, canoeing, and aesthetic enjoyment). **(F)** Commerce and navigation. **(G)** Tribal Cultural

Table 5.1 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Parameter	Surface Water Classes of the Lummi Indian Reservation			
	Class AA Extraordinary	Class A Excellent	Class B Good	Lake Class
Fresh Water Fecal Coliform Bacteria Geometric Mean Density	Shall both not exceed 50 colonies/100 ml AND not exceed 100 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 100 colonies/100 ml AND not exceed 200 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 200 colonies/100 ml AND not exceed 400 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 50 colonies/100 ml AND not exceed 100 colonies/100 ml in more than 10% of the samples obtained for calculation purposes
Marine Water Fecal Coliform Bacteria Geometric Mean Density	Shall both not exceed 14 colonies/100 ml AND not exceed 43 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 14 colonies/100 ml AND not exceed 43 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	Shall both not exceed 100 colonies/100 ml AND not exceed 200 colonies/100 ml in more than 10% of the samples obtained for calculation purposes	N/A
Fresh Water Enterococci	Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 61 colonies/100 ml	Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 61 colonies/100 ml	Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 78 colonies/100 ml	Shall both not exceed a geometric mean density of 33 colonies/100 ml AND not exceed a single sample maximum allowable density of 61 colonies/100 ml
Marine Water Enterococci	Shall both not exceed a geometric mean density of 35 colonies/100 ml AND not exceed a single sample maximum allowable density of 104 colonies/100 ml	Shall both not exceed a geometric mean density of 35 colonies/100 ml AND not exceed a single sample maximum allowable density of 104 colonies/100 ml	Shall both not exceed a geometric mean density of 35 colonies/100 ml AND not exceed a single sample maximum allowable density of 158 colonies/100 ml	N/A

Table 5.1 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Parameter	Surface Water Classes of the Lummi Indian Reservation			
	Class AA Extraordinary	**Class A Excellent**	**Class B Good**	**Lake Class**
Fresh Water Dissolved Oxygen Concentration	The seven-day mean minimum shall both not be less than 11.0 mg/l AND not have a spatial median intergravel dissolved oxygen concentration below 8.0 mg/l. If minimum spatial median intergravel dissolved, oxygen is 8.0 mg/l or greater, the minimum dissolved oxygen criterion is 9.0 mg/l. Where barometric pressure and temperature preclude attainment of criteria, dissolved oxygen must not be less than 95% of saturation.	Shall not be less than 8.0 mg/l. Where barometric pressure and temperature preclude attainment of criteria, dissolved oxygen must not be less than 90% of saturation.	Shall not be less than 6.5 mg/l.	No measurable decrease from natural conditions
Marine Water Dissolved Oxygen Concentration	Shall exceed a 1-day minimum daily concentration of 7.0 mg/l	Shall exceed a 1-day minimum daily concentration of 6.0 mg/l	Shall exceed a 1-day minimum daily concentration of 5.0 mg/l	N/A
Fresh Water Temperature	Shall not exceed a 7-day average of the daily maximum value (7DADM) temperature of 16.0°C. For summertime spawning, temperature shall not exceed a 7DADM temperature of 13.0°C.	Shall not exceed a 7DADM temperature of 17.5°C.	Shall not exceed a 7DADM temperature of 17.5°C.	No measurable increase from natural conditions

Table 5.1 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Parameter	Surface Water Classes of the Lummi Indian Reservation Class AA Extraordinary	 Class A Excellent	 Class B Good	 Lake Class
Marine Water Temperature	Shall not exceed a 1-day maximum temperature of 13.0°C	Shall not exceed a 1-day maximum temperature of 16.0°C	Shall not exceed a 1-day maximum temperature of 19.0°C	N/A
Fresh Water pH	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	No measurable change from natural conditions
Marine Water pH	7.0 – 8.5	7.0 – 8.5	7.0 – 8.5	N/A
Turbidity	Shall not exceed 5 NTU over background turbidity when background turbidity is less than or equal to 50 NTU OR not increase by more than 10% when the background turbidity is greater than 50 NTU	Shall not exceed 5 NTU over background turbidity when background turbidity is less than or equal to 50 NTU OR not increase by more than 10% when the background turbidity is greater than 50 NTU	Shall not exceed 5 NTU over background turbidity when background turbidity is less than or equal to 50 NTU OR not increase by more than 20% when the background turbidity is greater than 50 NTU	Shall not exceed 5 NTU over background turbidity
Toxic, Radioactive, Or Deleterious Material Concentrations	Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.	Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.	Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.	Shall be less than concentrations that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chromic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health as determined by the Director.

Table 5.1 Summary of Water Quality Criteria and Uses of the Various Classes of Lummi Indian Reservation Surface Waters

Parameter	Surface Water Classes of the Lummi Indian Reservation			
	Class AA Extraordinary	Class A Excellent	Class B Good	Lake Class
Aesthetic Values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste or taint the flesh of edible species

6. SURFACE WATER QUALITY SAMPLE RESULTS AND REGULATORY COMPLIANCE

Water quality sample results for 2009 and water quality sample results for the period of record through 2008 at each site were compared with the applicable water quality standards associated with each sample site. The water quality standard values are depicted as horizontal lines in the graphs presented in this section of the report. For each sample site the maximum and minimum results are summarized as vertical bars. Sample site identification codes, corresponding to the sample site locations shown in Figure 4.1 and Figure 5.1 and listed in Table 4.1 and Table 4.2, are presented along the X-axis. The number of observations/sample results is shown just above the X-axis next to the respective bar. Turbidity results are depicted differently because turbidity water quality standards are expressed as relative to the background turbidity level, which is dependent on a number of factors including flow, time of year, and sediment load. The turbidity sample results are averaged to characterize the relative turbidity levels at each sample site. Although there are currently no applicable water quality standards, the sample results for total suspended solids (a measure of turbidity), phosphorus, and total nitrogen are also summarized.

The use of bar graphs to present the sample program results allows:

- The various sites within a specific water body classification to be compared to each other;
- The sample results to be compared with the applicable water quality standards;
- The sample results from 2009 to be compared with the sample results over the period of record through 2008.

However, the bar graphs do not allow for a presentation of seasonal variations or trends as the data are for the entire reporting period for the site rather than over time. In addition, because the bar graphs for water temperature, dissolved oxygen, and pH show the maximum and minimum of the measured values, a single measurement above or below a water quality criteria/threshold suggests that the standards are not achieved at the site even though a single sample result may be an anomaly.

To address these limitations, the bar graphs for the various parameters are supplemented with graphs from a representative sample site from the same water body classification to depict seasonal variations and trends over the period of record. The selected representative fresh water sample sites are along the Lummi River and the Nooksack River. These water bodies are the two largest fresh water bodies that discharge to marine waters on the Reservation. Both of these water bodies originate off-Reservation and both are classified as Class AA waters. A Class A fresh water body was not selected as a representative site since all of the Class A fresh water bodies are ephemeral streams that are seasonally dry, have low discharges when they have flow during the rainy season, and have been shown to have minimal or no measurable impact on the water quality of the receiving marine waters (LWRD 1999, LWRD 2006c, LWRD 2006d). As a result, the representative fresh water site associated with the Class A marine water site is a Class AA site located along the Nooksack

River (Site SW018/SW118). The representative sample sites used to depict seasonal variations and trends are the following:

- Class AA Fresh Water: Site SW009 (Lummi River at Slater Road)
- Class AA Marine Water: Site SW002 (Lummi Bay)
- Class AA Fresh Water: Site SW118 (Nooksack River below Marine Drive – formerly Site SW018).
- Class A Marine water: Site SW030 (Bellingham Bay between the Nooksack River Delta and Portage Bay)

Sample Site SW018 was moved approximately 200 feet downstream along the west bank of the Nooksack River during 2008 to ensure safe access to the sampling location. The new sample site location was assigned the identifier Site SW118 but the samples at this site are from essentially the same water that was sampled at the discontinued Site SW018.

6.1. Fecal Coliform Bacteria Results

Bacteria sampling is routinely conducted at each of the current surface water quality sampling locations. Pursuant to the *Lummi Nation Water Quality Monitoring Program Quality Assurance/Quality Control Plan – Version 3.0* (LWRD 2006a) the collected samples are transported on ice to a contracted analytical laboratory the day of collection and tested for fecal coliform bacteria, *E. coli*, and enterococcus. Water from one sample bottle is used for each of the tests, and fecal coliform bacteria and *E. coli* are enumerated from the same growth plates.

To allow comparison to the applicable water quality standards, the bar graphs for the bacteria types depict the geometric mean and 90th percentile for fecal coliform bacteria and *E. coli* and the geometric mean and maximum value for enterococcus bacteria for each site. As summarized in Table 5.1, the water quality standards for enterococcus bacteria set maximum bacteria counts. If sample results show a higher count than the applicable water quality standard, the water quality standard is not met and the characteristic uses of the water body are not supported.

6.1.1. Class AA Waters

The Class AA fresh water standards for fecal coliform bacteria are a geometric mean not to exceed 50 colony forming units (cfu) per 100 milliliters (ml) <u>and</u> a 90th percentile standard of 100 cfu/100 ml (from the values used to calculate the geometric mean). Although sample Site SW018, is shown in Figure 6.1 to have met this standard during 2009, these results reflect the laboratory findings from one sample. As described above, SW018 was moved downstream and the sample site identifier changed to SW118. Site SW118 did not achieve the 90th percentile water quality standard during 2009. As shown in Figure 6.1 and Figure **6.2**, the geometric mean was below the standard at 8 of the 15 sample sites for the period of record. However, because the 90th percentile criterion was exceeded at all of the sites, the water quality standard for fecal coliform bacteria was not achieved at any of the Class AA fresh water sites either during 2009 or for the period of record. The site with the highest geometric mean and 90th percentile during 2009 was Site SW011 along Jordan Creek at Slater Road (the northern Reservation boundary). All of the sample sites along the northern

Reservation boundary (i.e., SW009, SW010, SW011, SW012, SW013, and SW014) have high fecal coliform bacteria geometric means and 90^{th} percentiles. Sample sites SW003 and SW058 are downstream from these sites along the boundary and also experienced periodic high fecal coliform bacteria counts. All of these water bodies' discharge to Lummi Bay where important shellfish beds are located.

Site SW118 is located along the Nooksack River where it flows onto the Reservation. High bacterial densities at this site represent a threat to the shellfish beds within and adjacent to Portage Bay and to the people who consume shellfish from these areas. The geometric mean for SW118, based on the most recent 30 sampling events during 2009, was 31 cfu/100 ml. This geometric mean is lower than the Lummi Nation fecal coliform bacteria geometric mean standard of 50 cfu/100 ml, and the Total Maximum Daily Load (TMDL) target of 39 cfu/100 ml established for the lower Nooksack River (Ecology 2000, 2002). The TMDL was established by the Washington Department of Ecology (Ecology) to be protective of the shellfish beds within and adjacent to Portage Bay and to protect the health of people who consume shellfish from these waters. The 90^{th} percentile value at SW118, based on the most recent 30 samples collected at this site during 2009, was 154 cfu/100 ml, which exceeds the standard. Because the water quality standards require that both the geometric mean and the 90^{th} percentile be achieved, the water quality standards at Site SW118 are not achieved and the designated uses are not supported.

The Class AA marine water quality standards for fecal coliform bacteria are more stringent than for Class AA fresh water and include a geometric mean not to exceed 14 cfu/100 ml and a 90^{th} percentile (from the values used to calculate the geometric mean) standard of 43 cfu/100 ml. As shown in Figure 6.3, 4 of the 11 sample sites met these criteria during 2009. As shown in Figure 6.4, these same four sites (SW001, SW002, SW019, and SW022) and Site SW055 have met the criteria for the period of record through 2008.

As shown in Figure 6.5, the fecal coliform bacteria sample results for the representative Class AA fresh water site that contributes to a Class AA marine water site (SW009 on the Lummi River along the northern Reservation boundary) have been consistently above the geometric mean and the 90^{th} percentile criteria over the period of record. In contrast, as shown in Figure 6.6, the fecal coliform bacteria sample results for the representative Class AA marine water site (SW002 in Lummi Bay) have been consistently below the geometric mean and 90^{th} percentile criteria over the period of record through 2008.

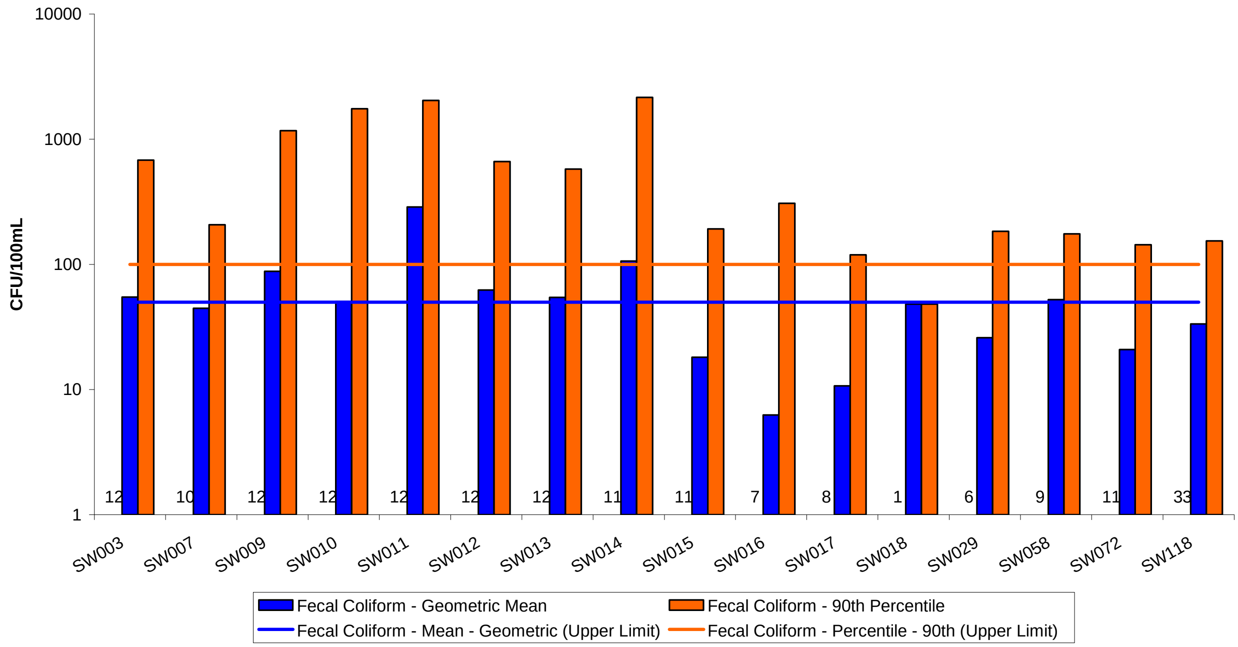

Figure 6.1 Class AA Fresh Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: 2009

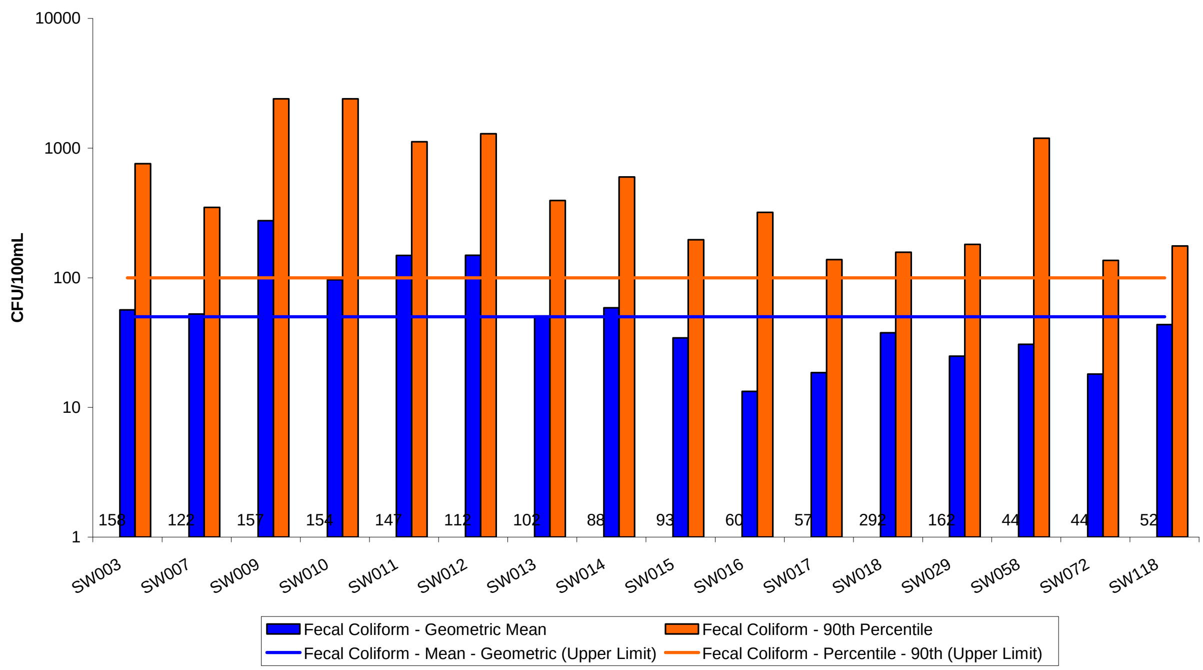

Figure 6.2 Class AA Fresh Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: Period of Record Through 2008

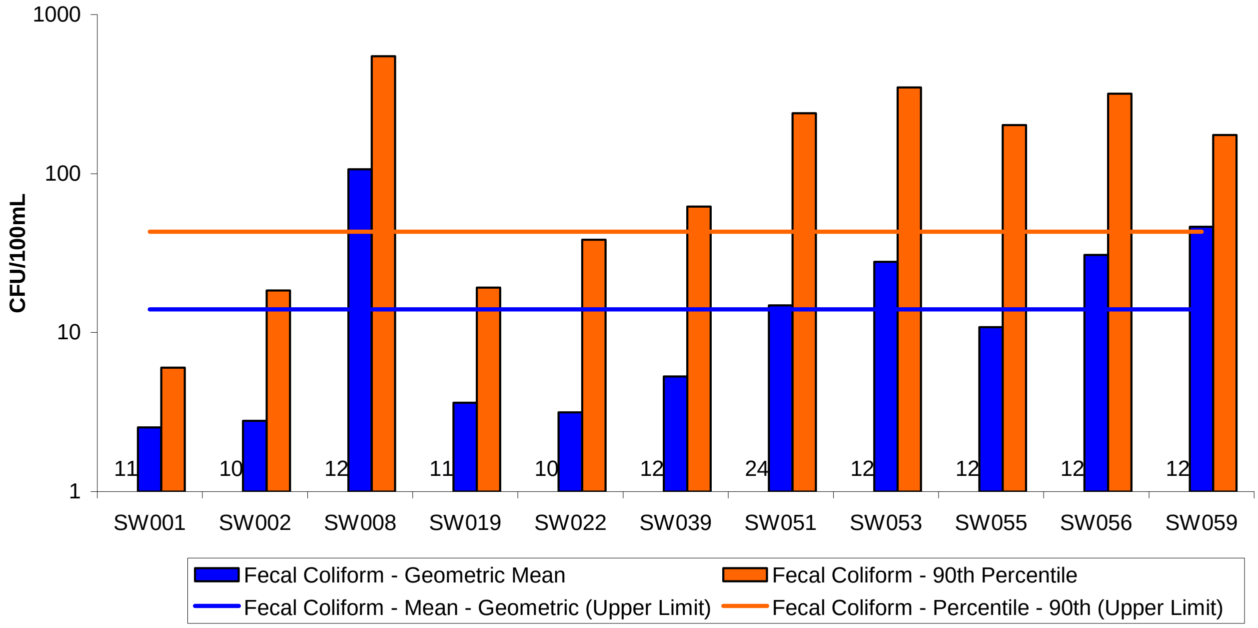

Figure 6.3 Class AA Marine Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: 2009

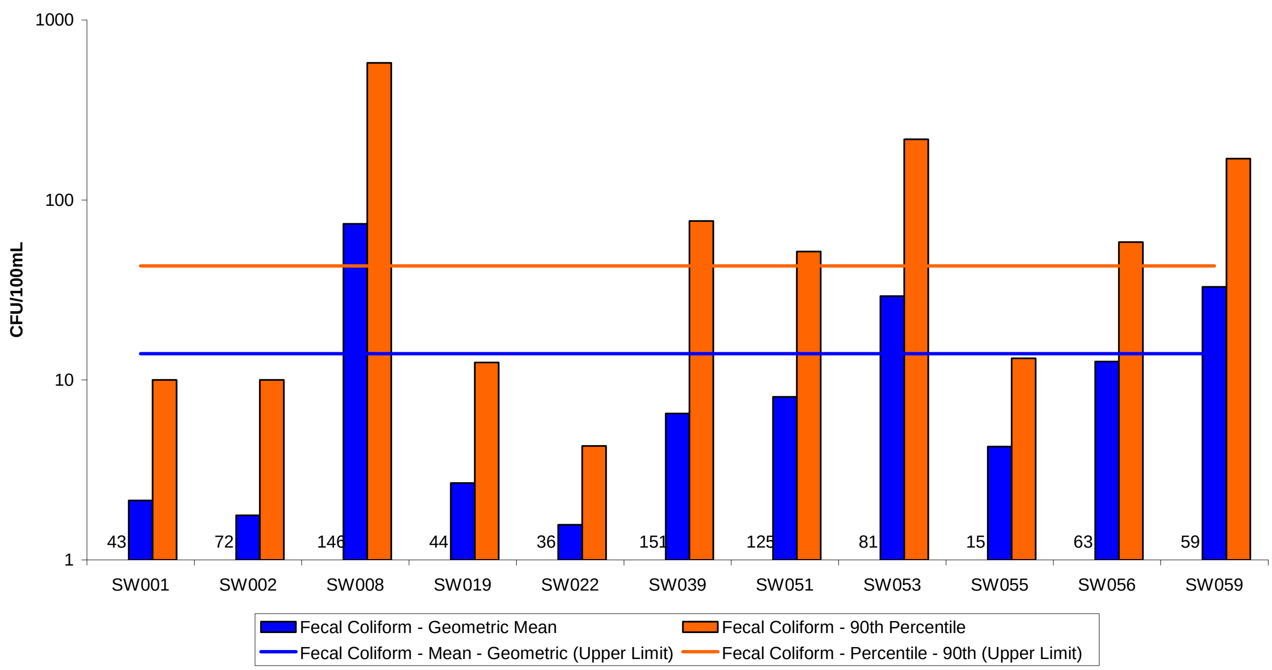

Figure 6.4 Class AA Marine Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: Period of Record Through 2008

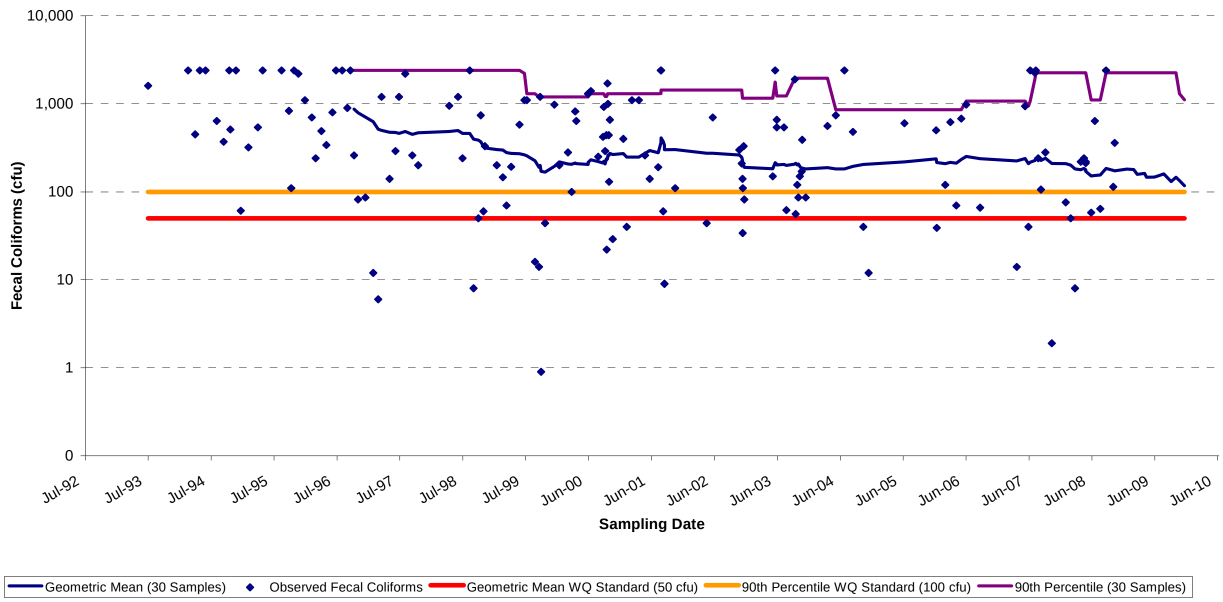

Figure 6.5 Class AA Fresh Water Fecal Coliform Bacteria Results – 30 Sample Running Geometric Mean and 90th Percentile at Site SW009

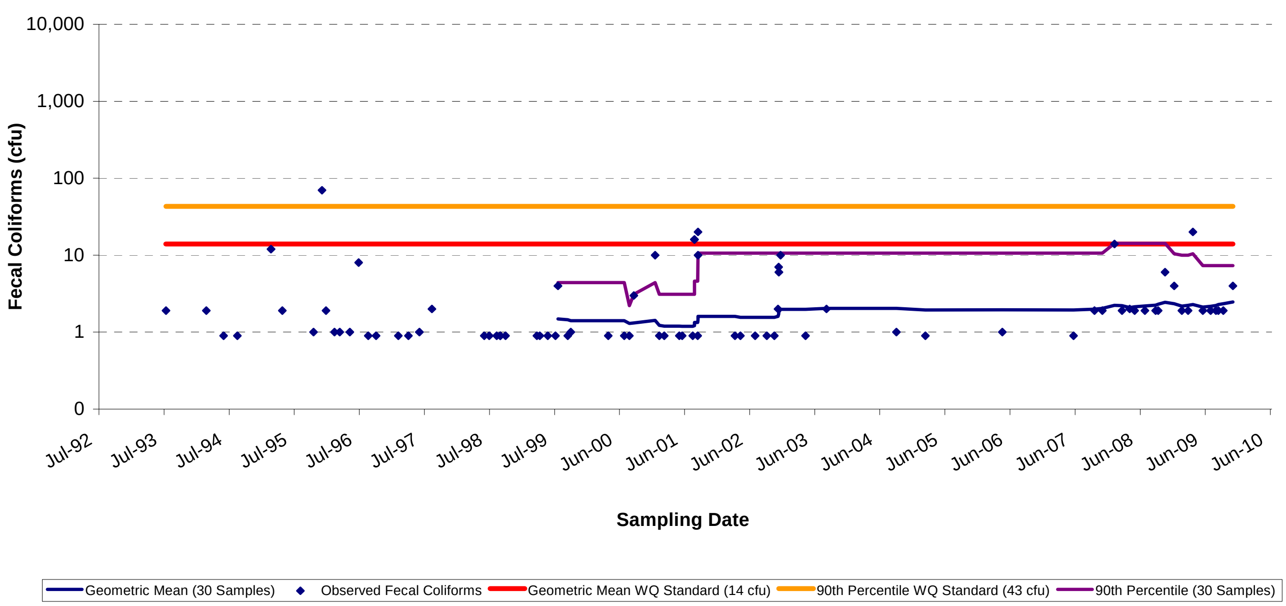

Figure 6.6 Class AA Marine Water Fecal Coliform Bacteria Results – 30 Sample Running Geometric Mean and 90th Percentile at Site SW002

6.1.2. Class A Waters

The Class A fresh water standard for fecal coliform bacteria are a geometric mean not to exceed 100 cfu/100 ml and a 90th percentile (from the values used to calculate the geometric mean) not to exceed 200 cfu/100 ml. Although sites SW024 and SW025 are shown in Figure **6.7** to have met the standards during 2009, these results reflect only one sample. Similarly, Site SW037 does not meet the standards but the results comprise only three samples. As shown in Figure 6.8, the geometric mean was below the standard at 5 of the 9 Class A fresh water sample sites for the period of record through 2008, but the 90th percentile values were above the standard at all 9 sites. The sites with the highest geometric mean and 90th percentile are located on Portage Island (SW024, SW025, SW026, SW027, and SW028). Although elevated fecal coliform bacteria levels have been sampled at the Class A freshwater sites, as noted above, the water bodies are seasonally dry and have low discharges during the rainy season. The results from an intensive sampling effort in the adjacent area along the Lummi Peninsula suggest that discharge from these sites have minimal or no measurable impact on the water quality of the receiving marine waters (LWRD 1999, LWRD 2006c, LWRD 2006d).

The Class A marine water quality standards for fecal coliform bacteria are more stringent than for Class A fresh water quality standards and include a geometric mean not to exceed 14 cfu/100 ml and a 90th percentile (from the values used to calculate the geometric mean) not to excced 43 cfu/100 ml. As shown in Figure 6.9, only SW006, a sample site near the middle of Portage Bay, met these criteria during 2009. As shown in Figure 6.10, Site SW006 and Site SW023 met the criteria for the period of record; all the sites had geometric means below the standard for the period of record. Site SW023 is also in Portage Bay just offshore of Portage Island and fresh water Site SW024.

Figure 6.11 depicts the 30 sample running geometric mean and 90th percentile of fecal coliform bacteria at the main stem of the Nooksack River just below the Marine Drive Bridge (SW018/SW118). Site SW018/SW118 is the representative Class AA fresh water site that contributes to a Class A marine water site. As shown in Figure 6.11, from 1998 through 2003 there is a general trend of decreasing fecal coliform bacteria densities. During late 2003 through 2004, fecal coliform bacteria densities increased and exceeded both the Lummi Nation Water Quality Standards (WQS) for Class AA fresh water and the TMDL target (Ecology 2000, 2002). Fecal coliform bacteria levels dropped below the Lummi Nation WQS and the TMDL target during late 2005 through early 2007. During this period, there also was reduced sampling due to staff changes. The fecal coliform bacteria geometric mean has decreased to below the TMDL Target in the last two years, however there continues to be periodic samples with high fecal coliform bacteria levels in the Nooksack River. Consequently, the fecal coliform bacteria levels are not meeting the 90th percentile standard.

Figure 6.12 depicts the 30 sample running geometric mean and 90th percentile of fecal coliform bacteria for Site SW030 in Bellingham Bay between the Nooksack River Delta and Portage Bay. The fecal coliform bacteria sample results for this representative Class A marine water site have been similar to the results from SW018/SW118 over the period of record. During 1998 through 2003, there was a general trend of decreasing fecal coliform bacteria density. Similar to the Nooksack River site (SW018/SW118), fecal coliform bacteria levels at the Bellingham Bay near shore site (SW030) increased from 2004 to present and exceeded the Lummi Nation WQS during 2009. The increasing trend of fecal coliform bacteria in the Nooksack River and Bellingham Bay is a concern because high bacteria densities at these sites represent a threat to the shellfish beds within and adjacent to Portage Bay and to the people who consume shellfish from these areas.

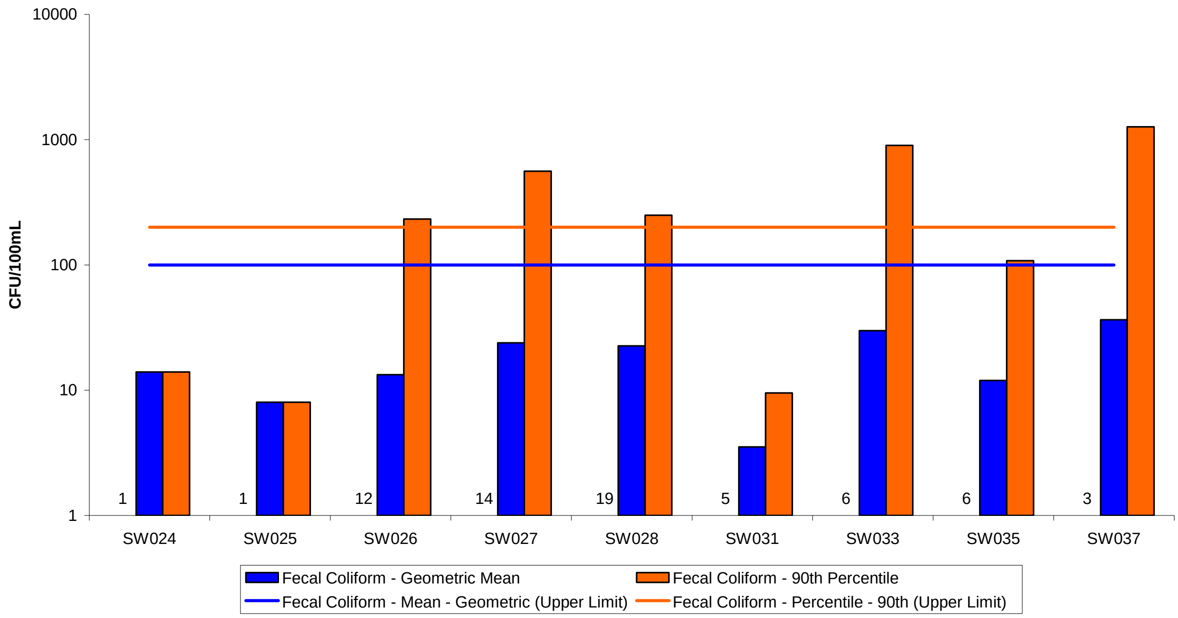

Figure 6.7 Class A Fresh Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: 2009

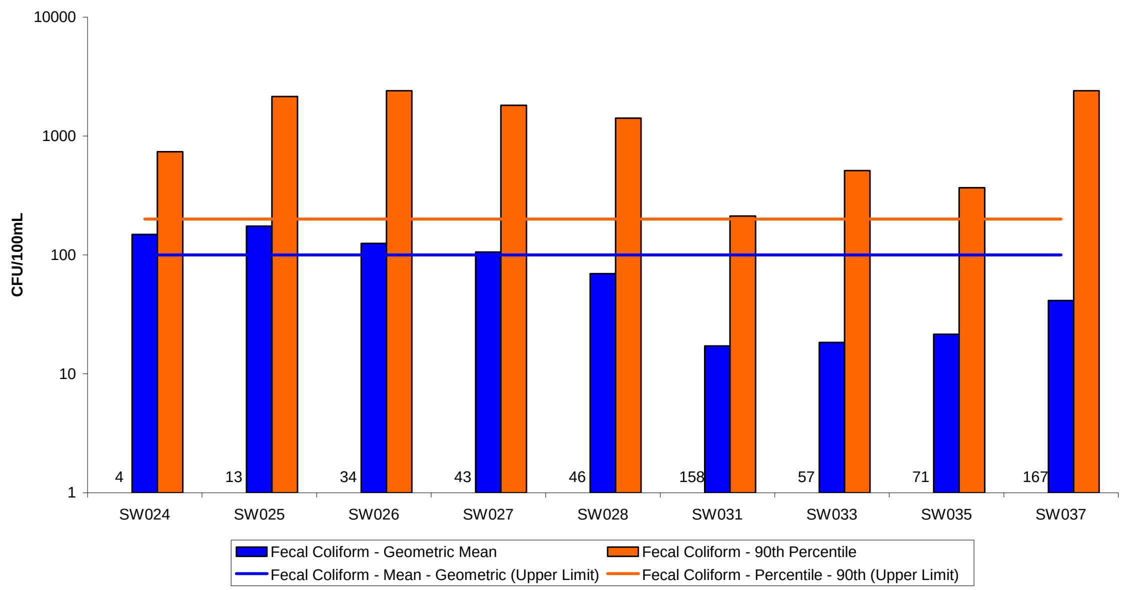

Figure 6.8 Class A Fresh Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: Period of Record through 2008

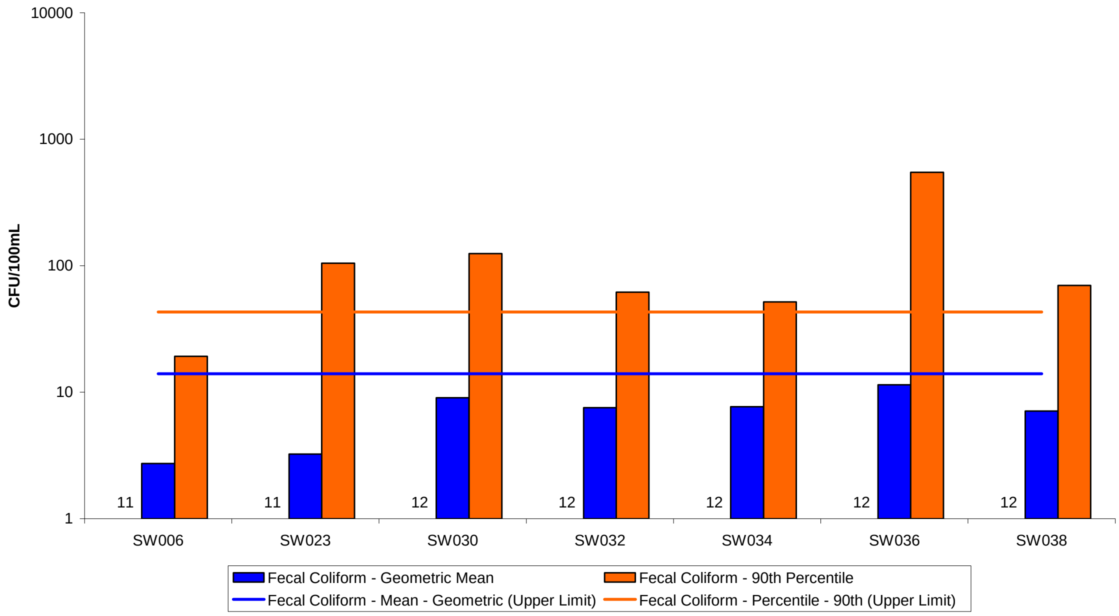

Figure 6.9 Class A Marine Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: 2009

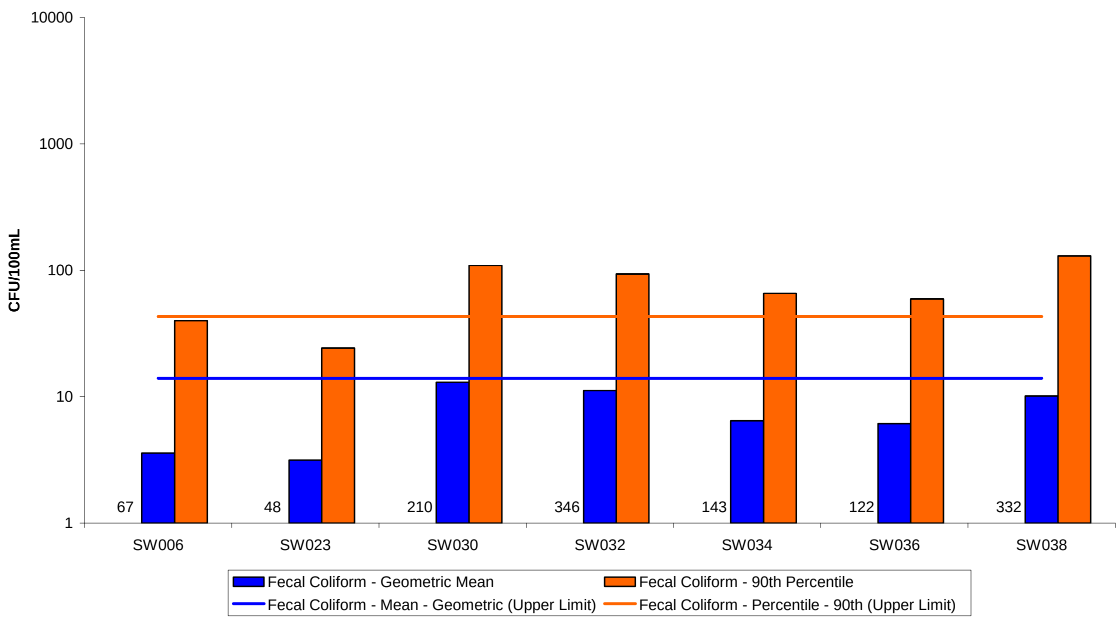

Figure 6.10 Class A Marine Water Fecal Coliform Bacteria Results Compared With Water Quality Standards: Period of Record through 2008

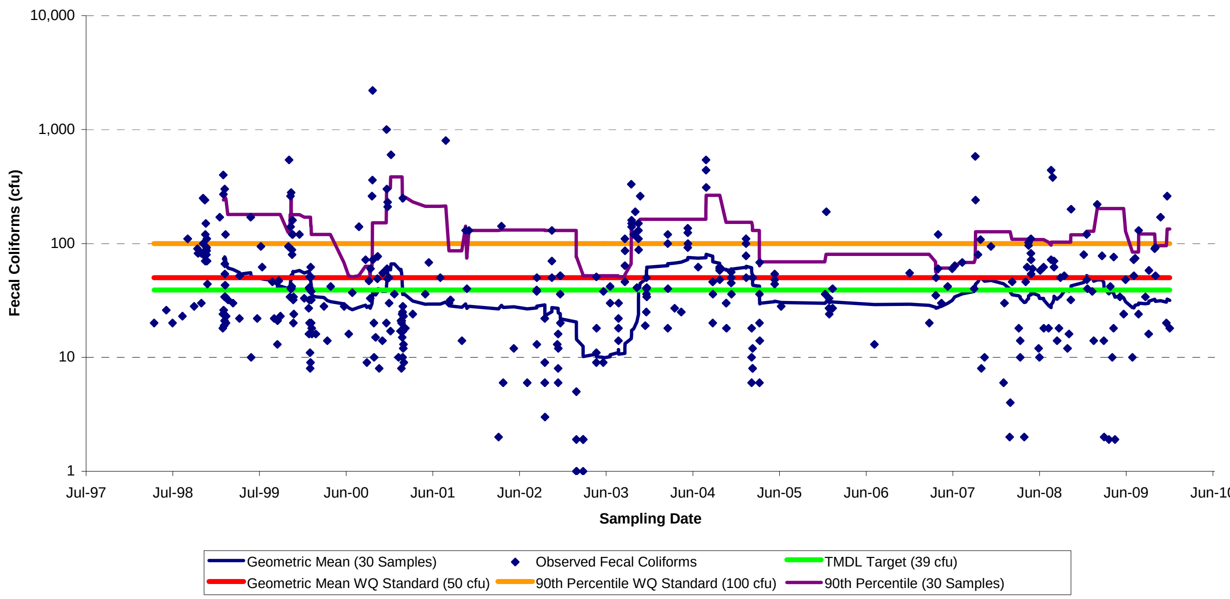

Figure 6.11 Class AA Fresh Water Fecal Coliform Bacteria Results – 30 Sample Running Geometric Mean and 90th Percentile at Site SW018/SW118 (Nooksack River)

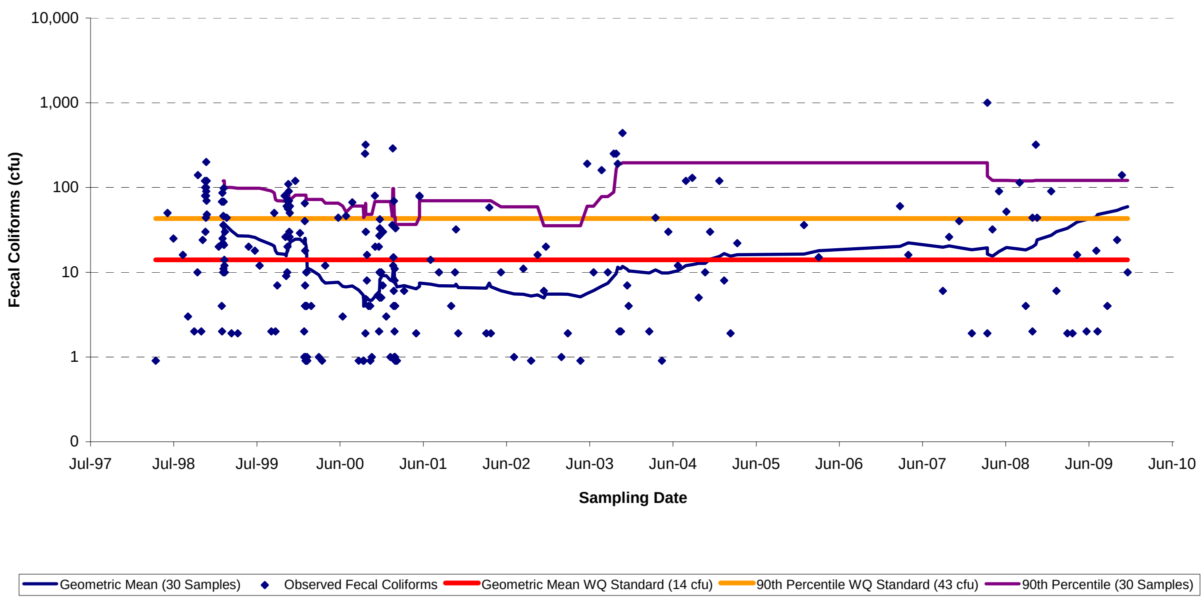

Figure 6.12 Class A Marine Water Fecal Coliform Bacteria Results – 30 Sample Running Geometric Mean and 90th Percentile at Site SW030

6.2. Enterococcus Results

As described in Section 6.1, collected water quality samples are transported on ice to a contracted analytical laboratory the day of collection and tested for fecal coliform bacteria, *E.coli,* and enterococcus. Water from one sample bottle is used for each of the tests; fecal coliform bacteria and *E. coli* are enumerated from the same growth plates.

6.2.1. Class AA Waters

The Class AA fresh water standards for enterococcus bacteria are a geometric mean not to exceed 33 cfu/100 ml <u>and</u> not exceed a single sample maximum allowable density of 61 cfu/100 ml. Similar to the fecal coliform bacteria results, Site SW018 as shown in Figure 6.13 met this standard during 2009 but these results reflect only one sample. As described in Section 6.1.1, SW018 was moved downstream and the sample site identifier changed to SW118, which in 2009 did not have water quality parameters that achieved the standard. As shown in Figure 6.14, the geometric mean was below the standard at 8 of the 16 sample sites for the period of record through 2008. However, because the 90^{th} percentile criterion was exceeded at all 16 sites, the water quality standard for enterococcus was not achieved at any of the Class AA fresh water sample sites for the period of record or during 2009. The site with the highest geometric mean and 90^{th} percentile was Site SW013, an agricultural ditch that discharges into the Lummi River. Additional sites along the northern Reservation boundary (SW009, SW010, SW011, SW012, and SW014) had high geometric mean and 90^{th} percentile values.

The Class AA marine water standards for enterococcus are a geometric mean not to exceed 35 cfu/100 ml <u>and</u> not exceed a single sample maximum allowable density of 104 cfu/100 ml. As shown in Figure 6.15, sites SW001, SW002, and SW022 met these criteria during 2009. All sample results at Site SW002 had values too low for the laboratory to detect (10 cfu/100ml) for enterococcus during 2009. As shown in Figure 6.16, sites SW001, SW002, SW019, SW022, and SW055 met the criteria for the period of record. The site with the highest geometric mean and 90^{th} percentile values was Site SW008, Lummi River at Hillaire Bridge. Site SW008 is downstream from Site SW009 on the Lummi River but is classified as a marine water site due to the observed salinity levels at the site. Similar to previous years, the water quality at Site SW009 during 2009 was of poorer quality than Site SW008.

As summarized in Table 6.1, the relation between fecal coliform bacteria and enterococcus bacteria varies by site and there is generally a poor relationship between the two types of bacteria. The best relationships, defined by the highest coefficient of determination (r^2) and slope of the best-fit line close to 1 was Site SW022 (Lummi Bay near Sandy Point). At Site SW022, as fecal colifom bacteria values increased, enterococcus values increased. Because fecal coliform bacteria occur in human feces, but can also be present in animal feces, soil, and submerged wood and in other places outside the human body, and enterococcus are typically a more human-specific subgroup within the larger fecal coliform bacteria group, the very good relationship at this site suggests that the source of fecal coliform bacteria is from human waste. The location of Site SW022 corresponds with an upland area where residents rely on on-site septic systems for waste disposal.

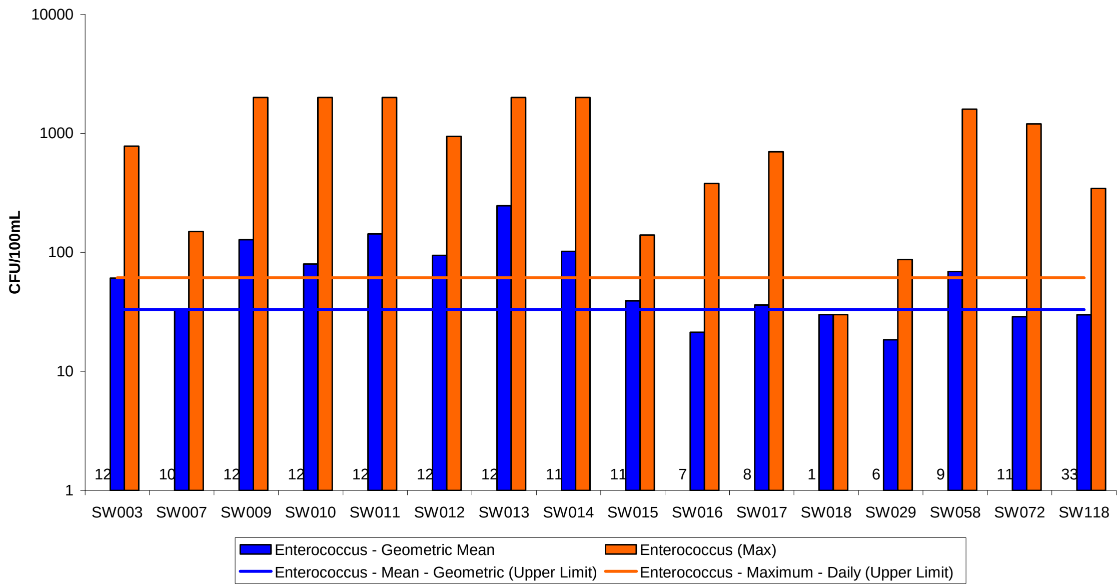

Figure 6.13 Class AA Fresh Water Enterococcus Bacteria Results Compared With Water Quality Standards: 2009

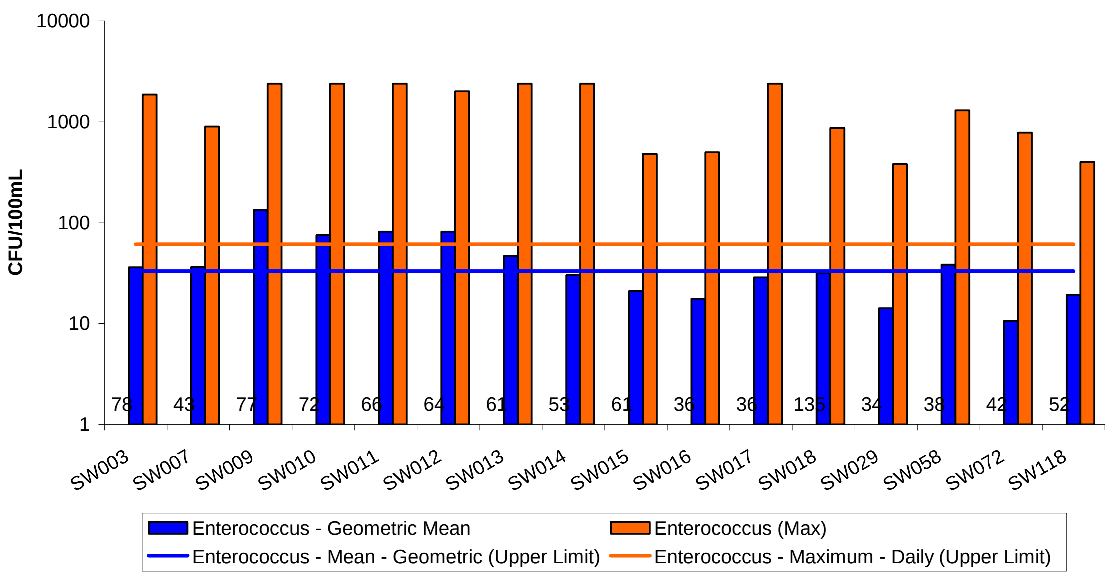

Figure 6.14 Class AA Fresh Water Enterococcus Bacteria Results Compared With Water Quality Standards: Period of Record through 2008

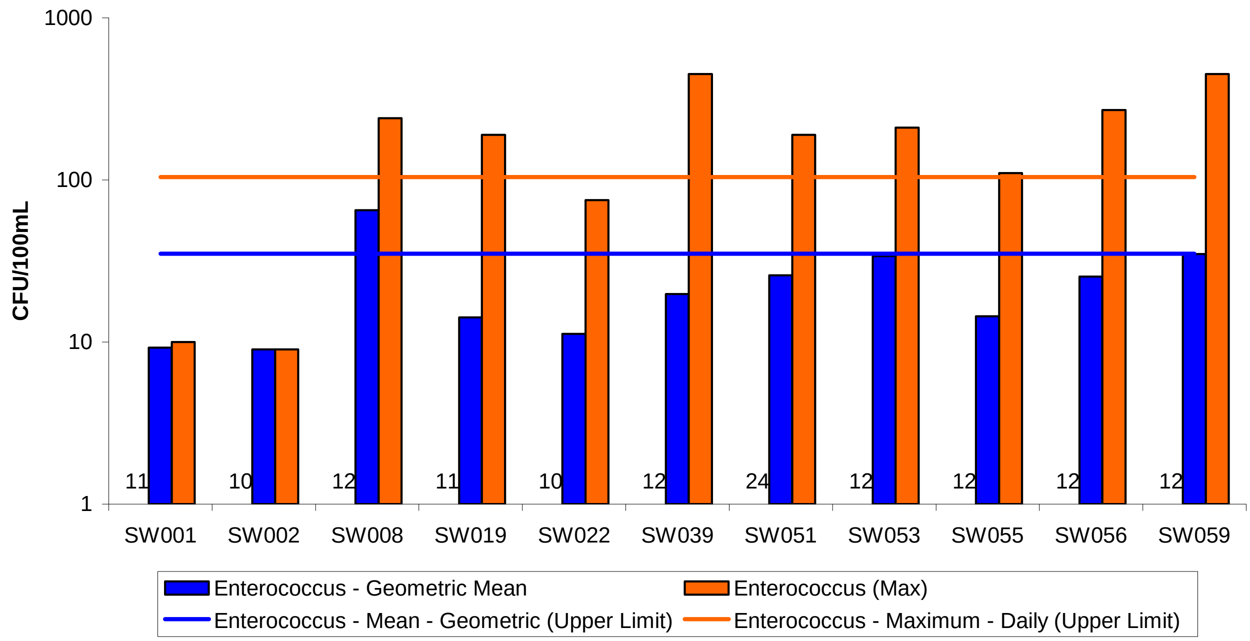

Figure 6.15 Class AA Marine Water Enterococcus Bacteria Results Compared With Water Quality Standards: 2009

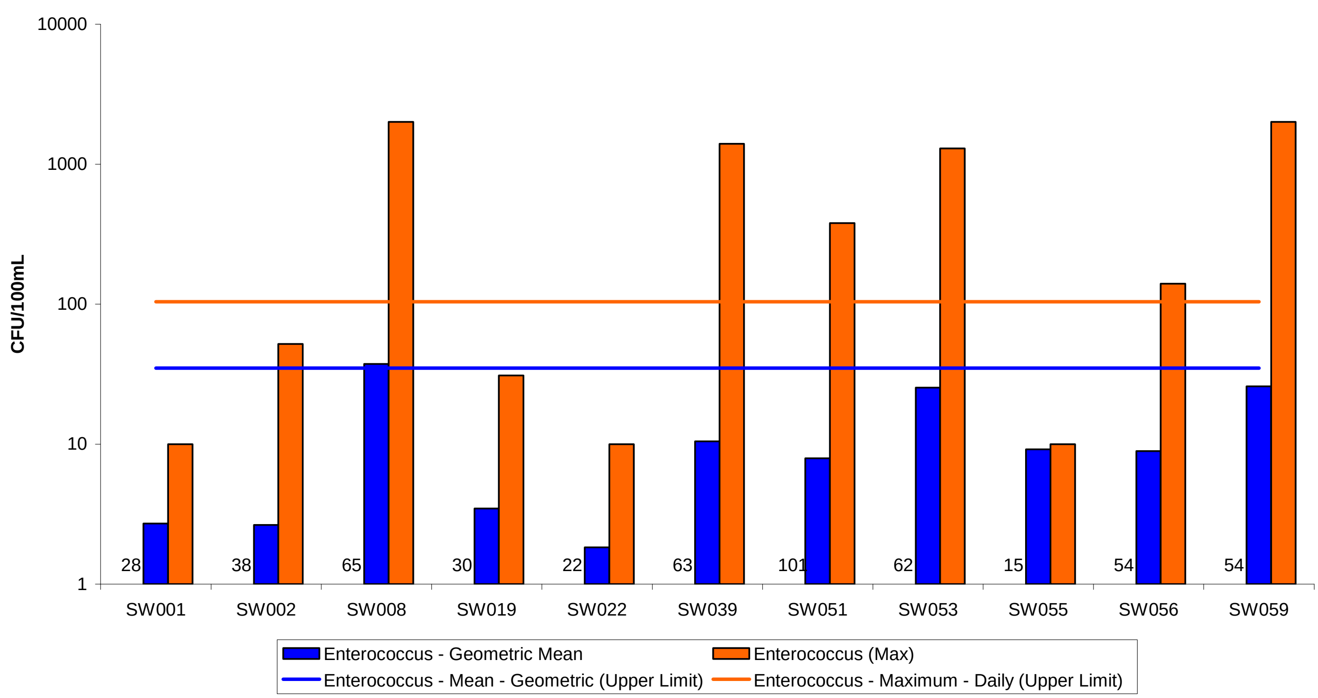

Figure 6.16 Class AA Marine Water Enterococcus Bacteria Results Compared With Water Quality Standards: Period of Record through 2008

Table 6.1 Relation Between Fecal Coliform and Enterococcus Bacteria – Class AA Waters

Sample Site Number	Number of Sample Pairs	Slope	Intercept	R-Square
Fresh Water				
SW003	90	1.12	-7.18	0.68
SW007	53	0.47	31.84	0.47
SW009	89	0.32	211.54	0.47
SW010	84	0.82	110.06	0.62
SW011	78	0.69	42.05	0.64
SW012	76	0.28	110.73	0.61
SW013	72	1.02	165.50	0.15
SW014	64	0.60	87.98	0.23
SW015	72	0.29	21.14	0.34
SW016	42	0.37	37.53	0.10
SW017	44	0.65	87.40	0.66
SW029	40	0.35	24.16	0.24
SW058	47	0.17	120.05	0.10
SW072	52	0.96	17.02	0.11
SW118	263	0.67	17.31	0.35
Marine Water				
SW001	39	0.32	4.64	0.09
SW002	48	0.64	3.44	0.18
SW008	77	0.27	51.88	0.55
SW019	41	1.79	4.38	0.18
SW022	32	1.73	1.66	0.92
SW039	76	2.06	20.90	0.08
SW051	124	0.26	16.49	0.14
SW053	74	1.71	14.53	0.62
SW055	27	0.14	11.89	0.12
SW056	66	0.06	19.56	0.06
SW059	66	0.96	-0.02	0.66

6.2.2. *Class A Waters*

The Class A fresh water standards for enterococcus bacteria include a geometric mean not to exceed 33 cfu/100 ml <u>and</u> not to exceed a single sample maximum allowable density of 61 cfu per 100 ml. Although sample sites SW024 and SW025 are shown in Figure 6.17 to have met this standard during 2009, these results reflect laboratory findings from only a single sample. Site SW031, a storm water outfall draining undeveloped parcels along the Portage Bay shoreline, met both standard requirements during 2009. As shown in Figure 6.18, the geometric mean was below the standard at 8 of the 9 sample sites for the period of record through 2008. However, because the 90th percentile criteria was exceeded at 8 of the 9 sites, the water quality standard for enterococcus was only achieved at Site SW024 for the period of record. Although Site SW024 met the water quality standard for enterococcus for the period of record, this result is also from a single sample. The site with the highest geometric mean and 90th percentile values both during 2009 and over the period of record is Site SW037, which is located along a relatively dense residential area along the Portage Bay shoreline.

The Class A marine water quality standards for enterococcus are a geometric mean not to exceed 35 cfu/100 ml <u>and</u> not to exceed a single sample maximum allowable density of 104 cfu/100 ml. As shown in Figure 6.19, the geometric mean component of the water quality standard was met at all sample sites, while the 90th percentile component was not achieved at any of the sites except SW006. As shown in Figure 6.20, similar to 2009, the geometric mean was lower than the standard at all sample sites but both criteria were not achieved for any of the sites for the period of record due to the exceedence of the 90th percentile criteria.

As summarized in Table 6.2, the relation between fecal coliform bacteria and enterococcus bacteria varies by site and there is a generally poor relationship between the two types of bacteria. The best relationships, as defined by the highest coefficient of determination (r^2) and the slope of the best-fit line closest to 1, is Site SW036 (along Lummi Peninsula/Portage Bay shoreline). The relationship between fecal coliform bacteria and enterococcus bacteria at Site SW036 is very good, as fecal coliform bacterial values increased enterococcus values increased. As described in section 6.2.1, a similar trend between fecal coliform and enterococcus indicates that the source of fecal coliform at Site SW036 is from human waste.

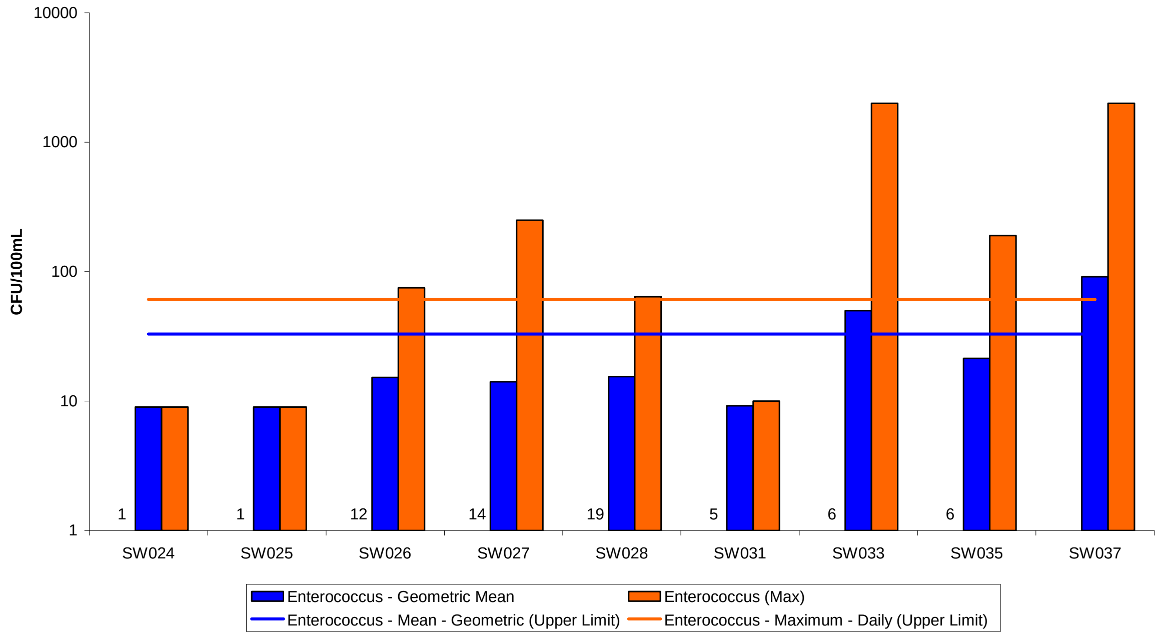

Figure 6.17 Class A Fresh Water Enterococcus Results Compared With Water Quality Standards: 2009

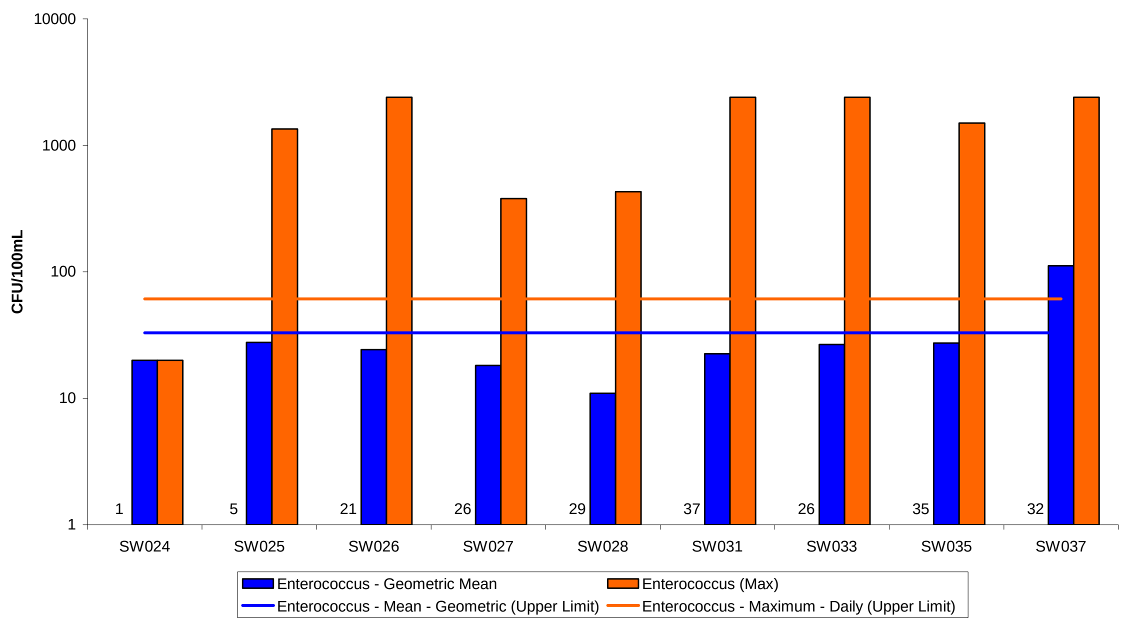

Figure 6.18 Class A Fresh Water Enterococcus Results Compared With Water Quality Standards: Period of Record through 2008

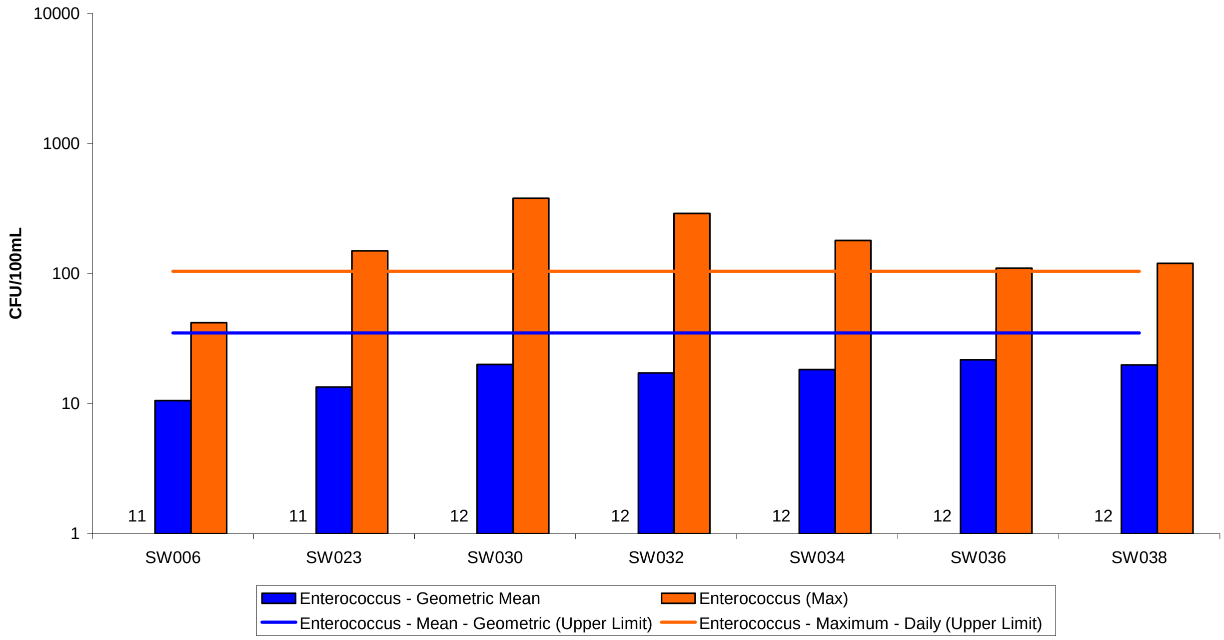

Figure 6.19 Class A Marine Water Enterococcus Results Compared With Water Quality Standards: 2009

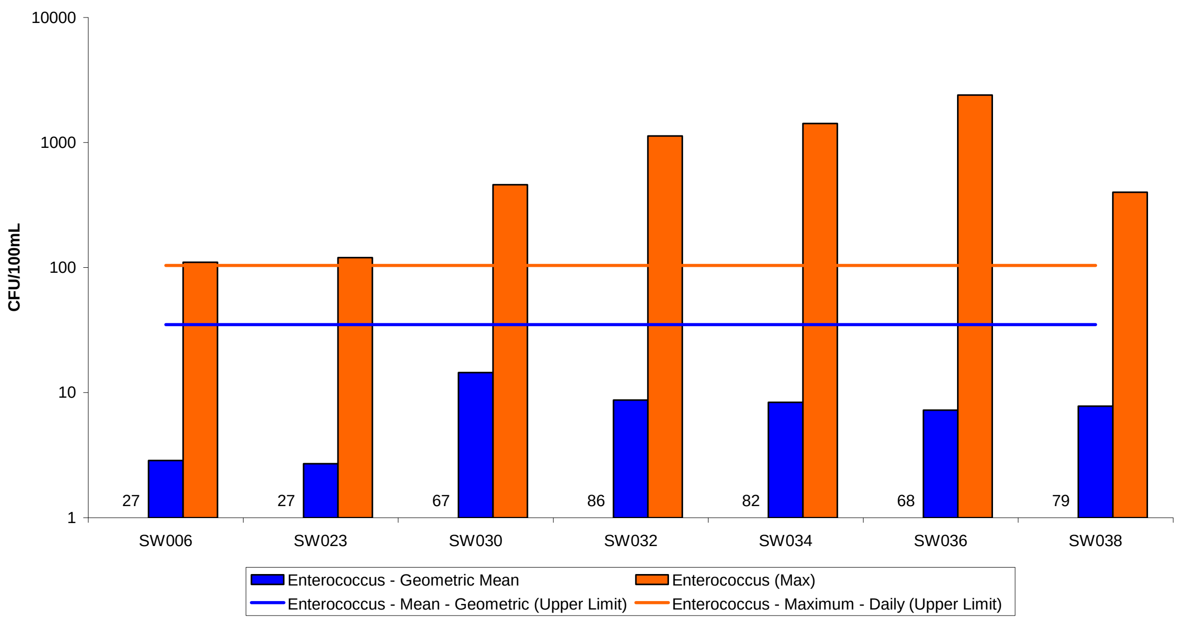

Figure 6.20 Class A Marine Water Enterococcus Bacteria Results Compared With Water Quality Standards: Period of Record through 2008

Table 6.2 Relation Between Fecal Coliform and Enterococcus Bacteria – Class A Waters

Sample Site Number	Number of Sample Pairs	Slope	Intercept	R-Square
Fresh Water				
SW025	6	0.64	-76.72	0.74
SW026	42	0.14	24.38	0.43
SW027	51	0.03	41.28	0.12
SW028	63	0.05	17.96	0.75
SW032	98	1.27	6.52	0.70
SW034	94	1.35	17.62	0.56
SW036	80	0.91	2.27	0.99
SW038	90	1.62	3.98	0.54
Marine Water				
SW006	38	0.96	1.80	0.80
SW023	38	0.98	1.49	0.84
SW030	81	0.15	38.78	0.08
SW031	42	1.47	50.88	0.70
SW033	32	4.57	-239.13	0.62
SW035	41	1.08	39.88	0.50
SW037	35	0.36	253.95	0.97

6.3. *Escherichia coli* Results

As described in Section 6.1, collected water quality samples are transported on ice to a contracted analytical laboratory the day of collection and water from one sample bottle is used for each of the tests for bacteria; fecal coliform bacteria and *Escherichia coli* (*E. coli*) are enumerated from the same growth plates.

Escherichia coli (*E. coli*) is a type of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals. The Lummi Nation did not establish a water quality standard for *E. coli*, primarily because fecal coliform bacteria is the criterion used to classify commercial shellfish beds in the federal Food and Drug Administration (FDA) National Shellfish Sanitation Program (NSSP). Although there is currently not an adopted water quality standard for *E. coli*, the Program samples for *E. coli* since the EPA recommends *E. coli* as the best indicator of health risk from water contact in recreational waters and because an *E. coli* standard might be adopted in the future.

6.3.1. Class AA Waters

As summarized in Table 6.3, the fecal coliform bacteria results are generally highly correlated (coefficients of determination greater than 0.90 and slope of the best-fit line close to 1) with the *E. coli* results. The generally high correlations are not surprising since *E. coli* is a species in the fecal coliform bacteria group. The high correlation indicates that the measured fecal coliform bacteria levels are from fecal material from humans and other warm-blooded animals rather than from other bacteria types that are not necessarily fecal in origin (e.g., *Klebsiella*). Although still highly correlated with a coefficient of determination greater than 0.65, the correlation between fecal coliform bacteria and *E. coli* at sample sites SW002 and SW007 are lower and the deviation from a 1:1 slope of a best fit line is notably greater than for the majority of the other sites. Sample Site SW001 (Sandy Point Channel) has the poorest relationship between fecal coliform bacteria and *E.coli*, which indicates that the *E.coli* are more likely to be from other bacteria types that are not necessarily fecal in origin.

The high correlation is reflected in similar trends of fecal coliform bacteria and *E.coli* densities at the majority of sample sites. As shown in Figure 6.21 and Figure 6.22, the Class AA fresh water sites with the highest geometric mean and 90th percentile values were sites SW009, SW010, SW011, and SW014 along the northern Reservation boundary. As shown in Figure 6.23 and Figure 6.24, the Class AA marine sites with the highest mean geometric mean and 90th percentile values were sites SW008, SW053, and SW059. Sample Site SW008 is downstream from Site SW009 on the Lummi River but is classified as a marine water site. Although the *E.coli* density at Site SW053 is high, it is lower than the respective upstream Site SW003.

Table 6.3 Relation Between Fecal Coliform Bacteria and *E.coli* – Class AA Waters

Sample Site Number	Number of Sample Pairs	Slope	Intercept	R-Square
Fresh Water				
SW003	128	1.00	-1.86	1.00
SW007	91	0.79	4.12	0.78
SW009	128	0.99	-12.28	0.99
SW010	131	1.00	-7.46	1.00
SW011	120	0.94	8.00	0.98
SW012	115	1.00	-21.56	0.99
SW013	114	0.99	-3.60	0.98
SW014	99	0.99	-4.06	0.99
SW015	103	1.00	-1.77	0.98
SW016	66	0.97	-7.39	0.96
SW017	65	1.00	-1.78	1.00
SW029	165	1.00	-2.84	0.99
SW058	53	0.88	-8.98	0.92
SW072	52	0.93	1.38	0.90
SW118	426	0.96	-0.77	0.96
Marine Water				
SW001	40	0.49	1.10	0.46
SW002	63	0.66	0.32	0.63
SW019	55	0.68	0.96	0.65
SW022	46	0.99	-0.09	0.99
SW008	116	0.98	-2.86	0.99
SW039	162	1.00	-0.93	0.99
SW051	148	0.99	-1.27	0.99
SW053	93	0.98	-1.47	0.97
SW055	27	0.96	-1.53	0.95
SW056	74	1.00	-0.78	1.00
SW059	70	1.00	-2.59	0.99

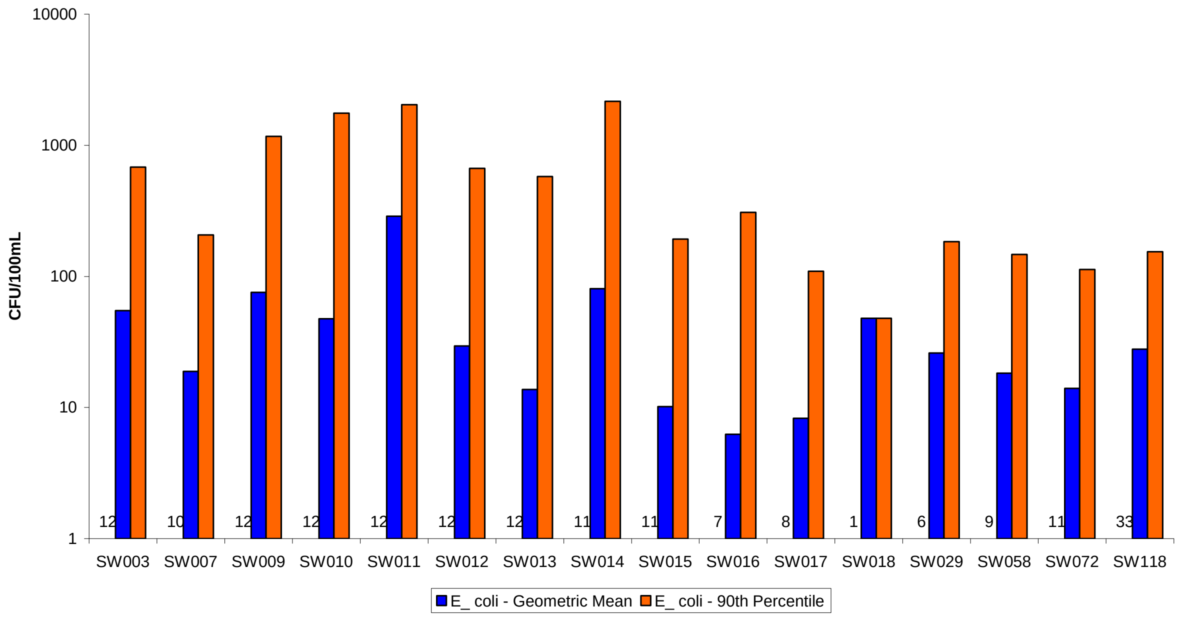

Figure 6.21 Class AA Fresh Water *E.coli* Results: 2009

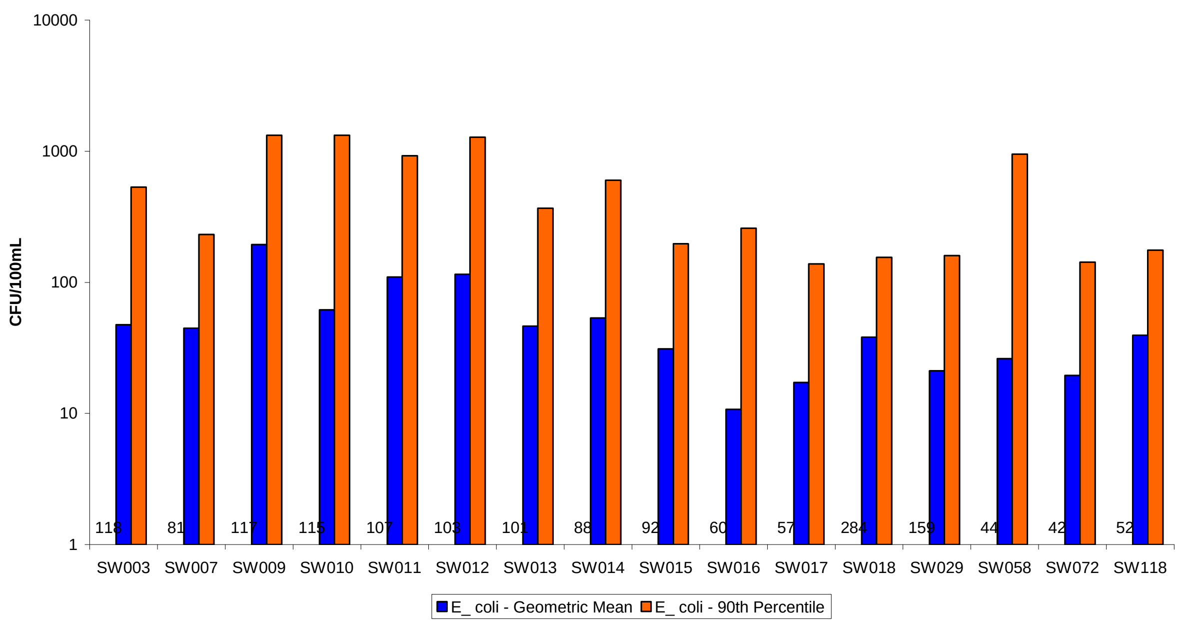

Figure 6.22 Class AA Fresh Water *E.coli* Results: Period of Record through 2008

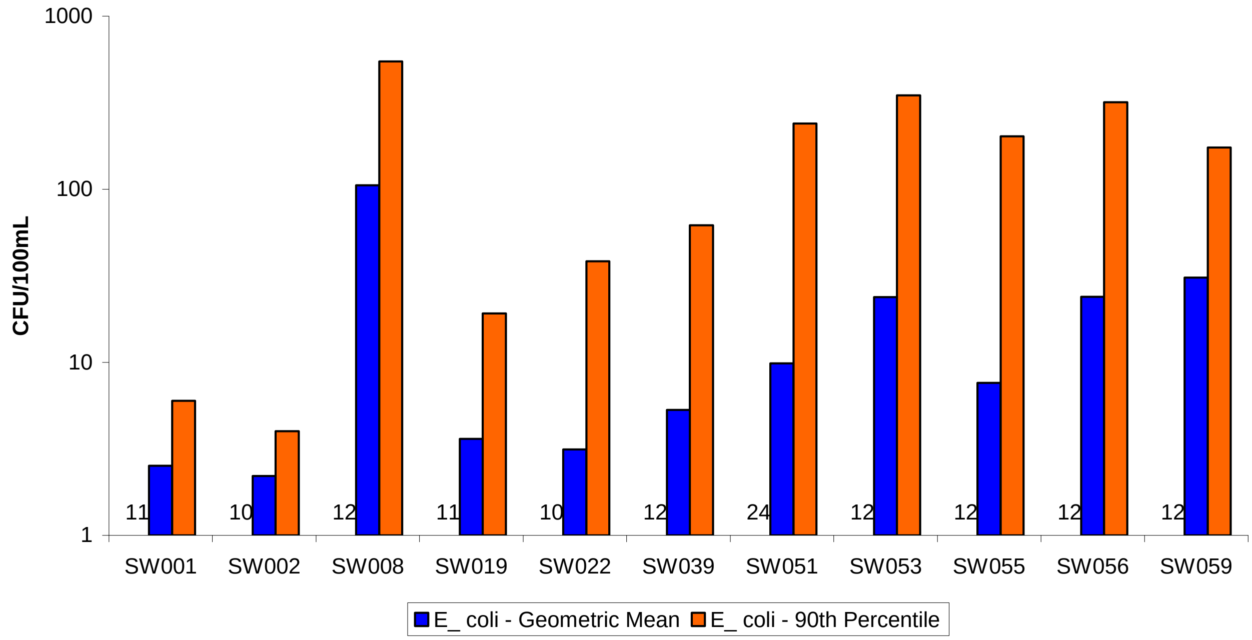

Figure 6.23 Class AA Marine Water *E.coli* Results: 2009

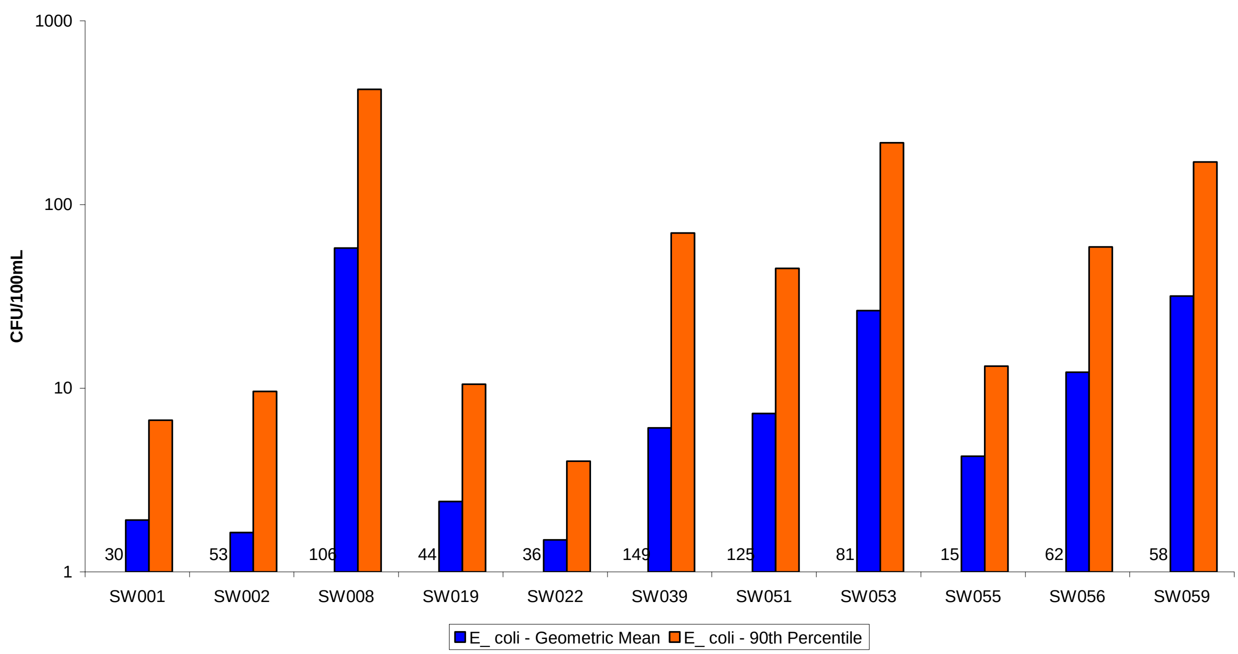

Figure 6.24 Class AA Marine Water *E.coli* Results: Period of Record through 2008

6.3.2. Class A Waters

As summarized in Table 6.4, the fecal coliform bacteria results for Class A waters were highly correlated (coefficients of determination greater than 0.90 and slope of the best-fit line close to 1) with the *E. coli* results. As described in section 6.3.1, the generally high correlations are not surprising since *E. coli* is a species in the fecal coliform bacteria group. The high correlation indicates that the fecal coliform bacteria are from fecal material from humans and other warm-blooded animals rather than from other bacteria types that are not necessarily fecal in origin (e.g., *Klebsiella*). Sample Site SW030 (in Bellingham Bay) has the poorest relationship between fecal coliform bacteria and *E.coli* with a coefficient of determination of 0.37 and slope of 0.60.

The high correlation between fecal coliform bacteria and *E.coli* is reflected in similar trends of fecal coliform bacteria and *E.coli* densities at sample sites. As shown in Figure 6.25 and Figure 6.26, the Class A fresh water sites with the highest geometric means and 90th percentiles are located on Portage Island (SW024, SW025, SW026, SW027, and SW028). In contrast, as shown in Figure 6.27 and Figure 6.28, sites SW006 and SW0023 located offshore of Portage Island had the lowest geometric mean and 90th percentile for Class A marine water sites. As shown in Figure 6.28, sites SW030, SW032, SW036, and SW038 have the highest geometric mean and 90th percentile for a Class A marine water.

Table 6.4 Relation Between Fecal Coliform Bacteria and *E.coli* – Class A Waters

Sample Site Number	Number of Sample Pairs	Slope	Intercept	R-Square
Fresh Water				
SW025	14	1.00	-68.22	0.98
SW026	55	1.00	0.26	1.00
SW027	67	0.99	-11.37	0.99
SW028	82	0.98	6.67	0.96
SW032	370	0.99	-16.10	0.99
SW034	163	1.00	-0.40	0.99
SW036	132	1.00	-0.61	1.00
SW038	355	1.00	-1.47	1.00
Marine Water				
SW006	65	1.00	-0.19	1.00
SW023	63	1.00	-0.25	0.99
SW030	222	0.60	16.46	0.37
SW031	162	1.00	0.70	1.00
SW033	61	1.00	-0.57	1.00
SW035	75	1.00	-2.60	1.00
SW037	164	1.00	-14.94	1.00

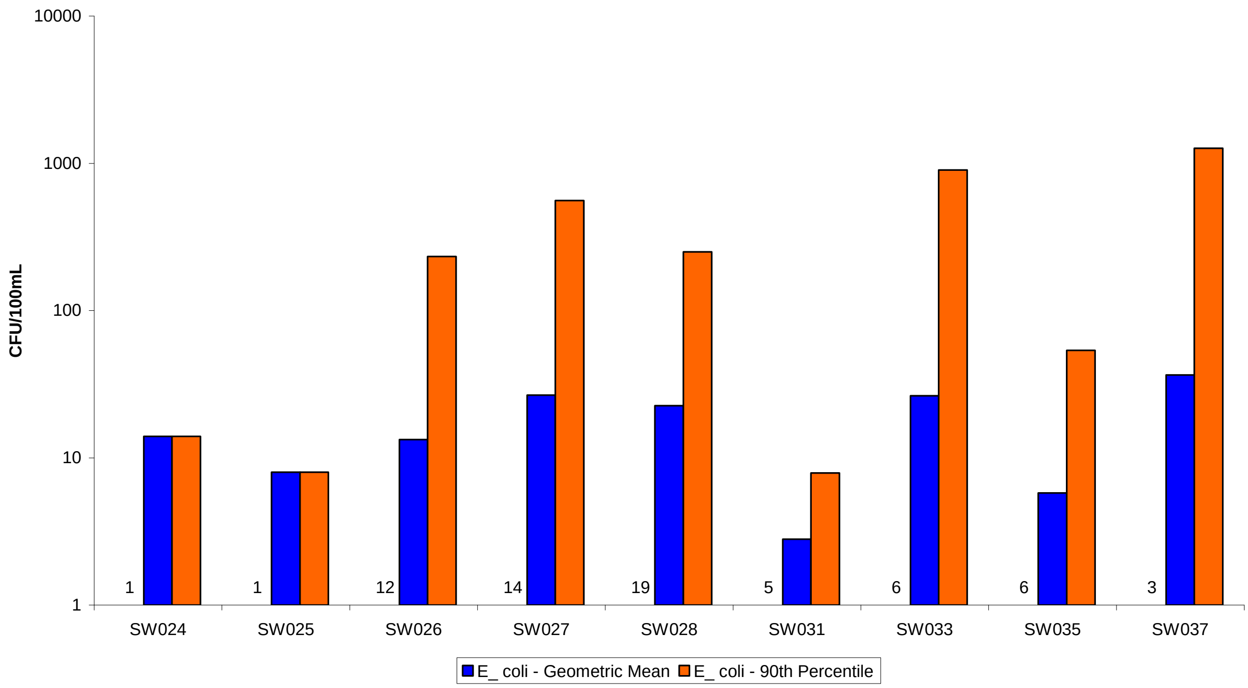

Figure 6.25 Class A Fresh Water *E.coli* Results: 2009

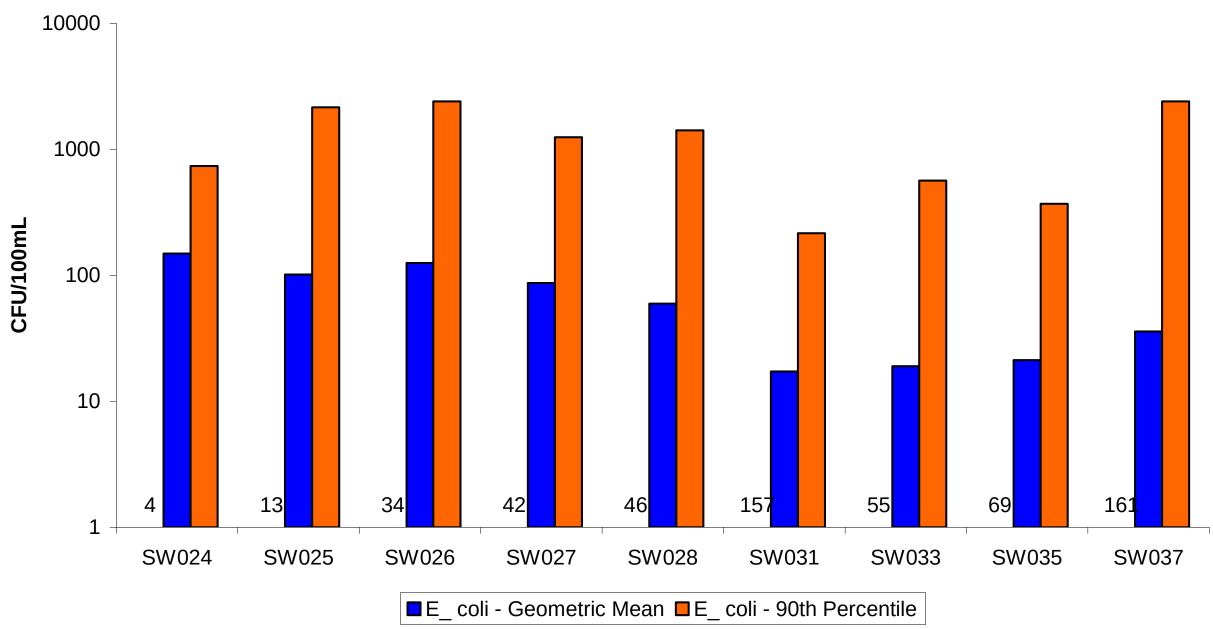

Figure 6.26 Class A Fresh Water *E.coli* Results: Period of Record through 2008

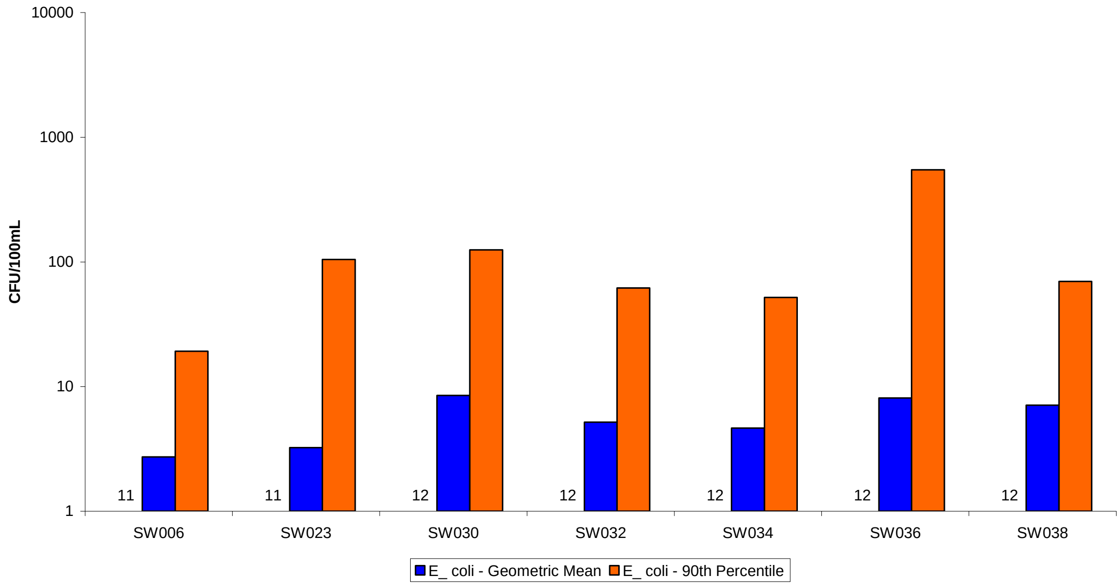

Figure 6.27 Class A Marine Water *E.coli* Bacteria Results: 2009

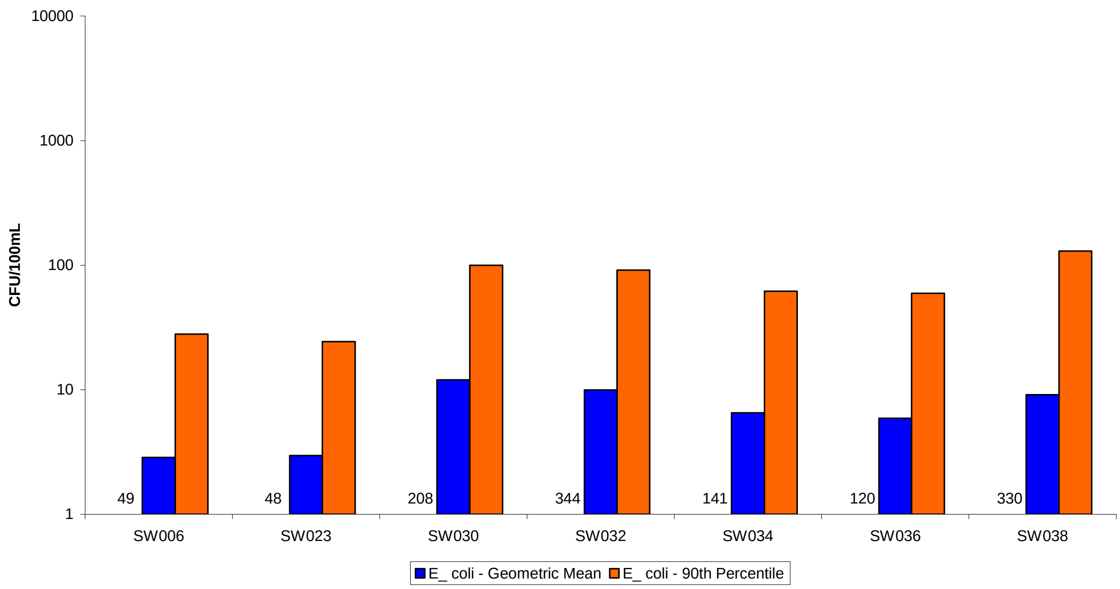

Figure 6.28 Class A Marine Water *E.coli* Bacteria Results: Period of Record through 2008

6.4. Water Temperature Results

Similar to bacteria, the water quality standards for water temperature are set at a maximum value. If the maximum measured water temperature is greater than the water quality criteria, the sample results suggest that the characteristic uses of the water body are not fully supported. The existing sampling program collects single measurements of water temperature during a sampling event that typically occurs each month. Since the water quality standards are expressed as the 7-day average of the daily maximum value in the case of fresh water sites, and the 1-day maximum temperature for marine water sites, the collected data do not allow a direct comparison with the applicable water quality standards. However, the sample results provide an indicator of whether the water quality standards were exceeded at that time. Continuous recording water temperature probes were deployed at 10 of the monitoring sites during 2009. Beginning in 2010, the data collected at the 10 sites with continuous temperature data loggers will allow direct comparison with the applicable water quality standards.

6.4.1. Class AA Waters

The Class AA fresh water quality standard for water temperature is a 7-day average of the daily maximum value (7DADM) temperature of 16.0°C. For summer time spawning, temperature shall not exceed a 7DADM temperature of 13.0°C. As shown in Figure 6.29, the water quality data collected during 2009 suggest that this standard was exceeded at 13 of the 16 sample sites. Although sample Site SW018 is shown in Figure 6.29 to have met this standard during 2009, these results reflect the laboratory findings from only one sample. As described previously, SW018 was moved downstream and the sample site identifier changed to SW118. As shown in Figure 6.29 and Figure 6.30, the water temperature was always below the standard at only one of the Class AA fresh water monitoring sites (SW029). Site SW029 is in a largely forested watershed that drains a portion of the Lummi Peninsula.

The Class AA marine water quality standard for water temperature is a 1-day maximum temperature of 13.0°C. As shown in Figure 6.31 and Figure 6.32, the water temperature exceeded the standard at least once at all of the Class AA marine water monitoring sites for 2009 and during the period of record through 2008.

As shown in Figure 6.33, the water temperature sample results for the representative Class AA fresh water site that contributes to a Class AA marine water site (SW009 on the Lummi River along the northern Reservation boundary) have generally been below the 16.0°C threshold over the period of record. In contrast, as shown in Figure 6.34, the water temperature sample results for the representative Class AA marine water site (SW002 in Lummi Bay) have commonly been above the 13.0°C threshold over the period of record. Site SW002 is located on the tide flats of Lummi Bay and the water temperature increases as the tidal waters flow over the mud flats. There is not an anthropogenic cause for the elevated temperatures at this location.

As shown in Figure 6.35, the water temperature at Site SW009 varies during the year with the highest temperatures occurring during June, July, August, and September and the lowest temperatures during December and January. As shown in Figure 6.36, a similar pattern occurs at Site SW002 except that the lowest temperature occurs during February.

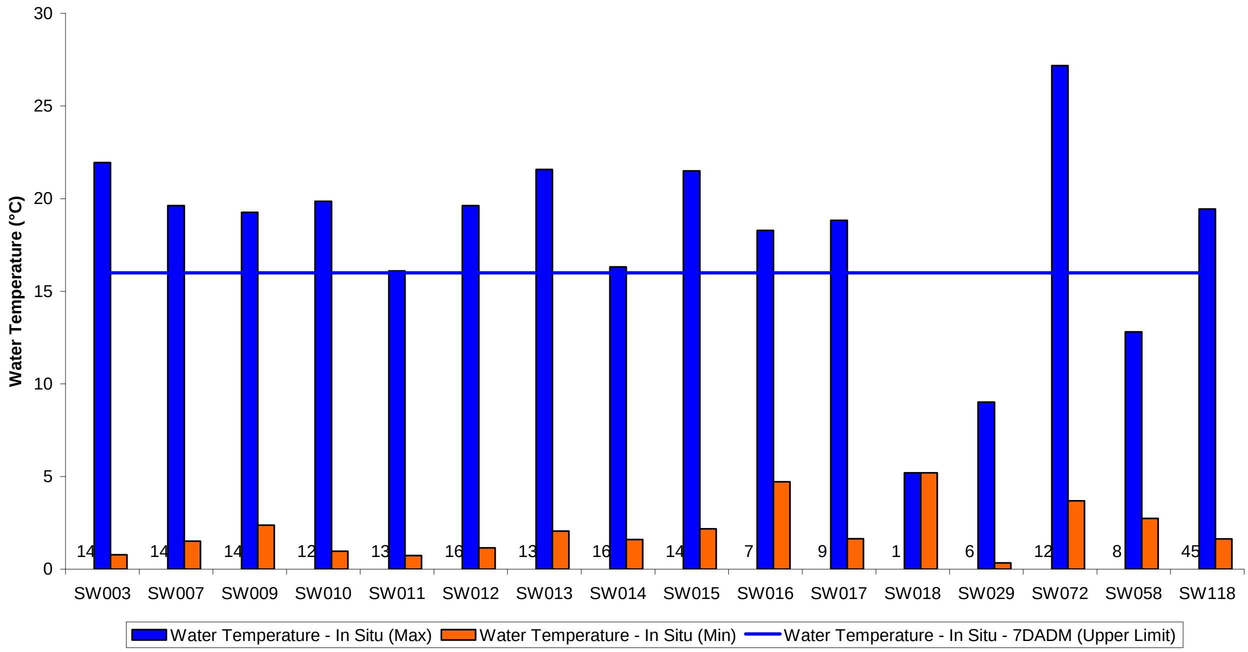

Figure 6.29 Class AA Fresh Water Temperature Results Compared With Water Quality Standards: 2009

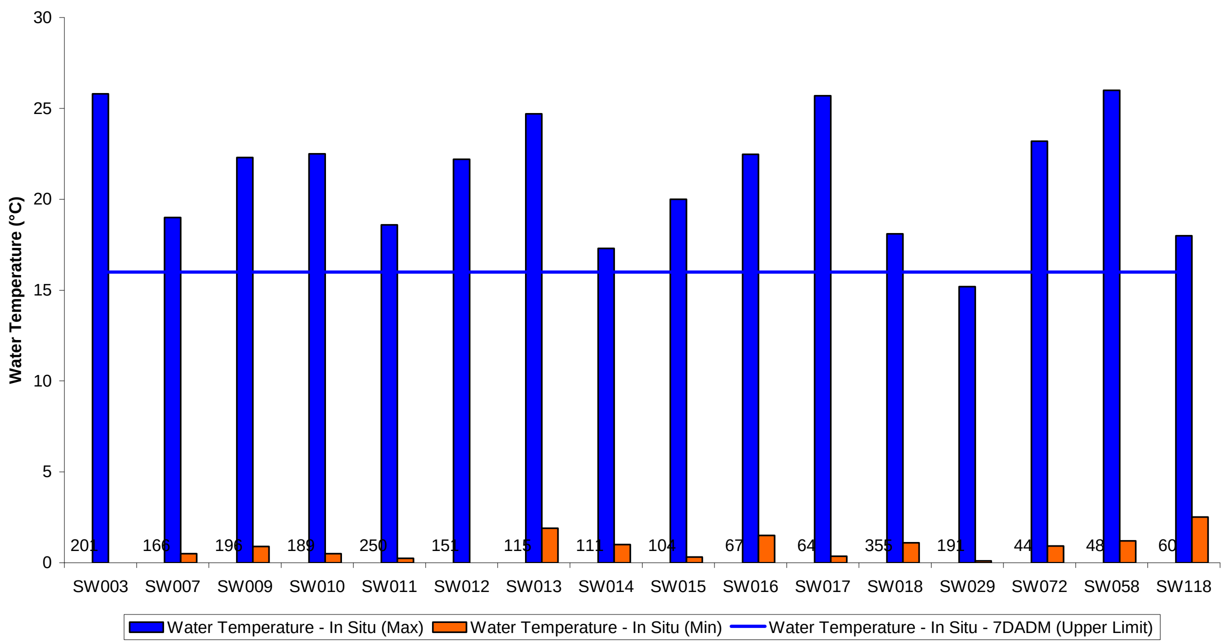

Figure 6.30 Class AA Fresh Water Temperature Results Compared With Water Quality Standards: Period of Record through 2008

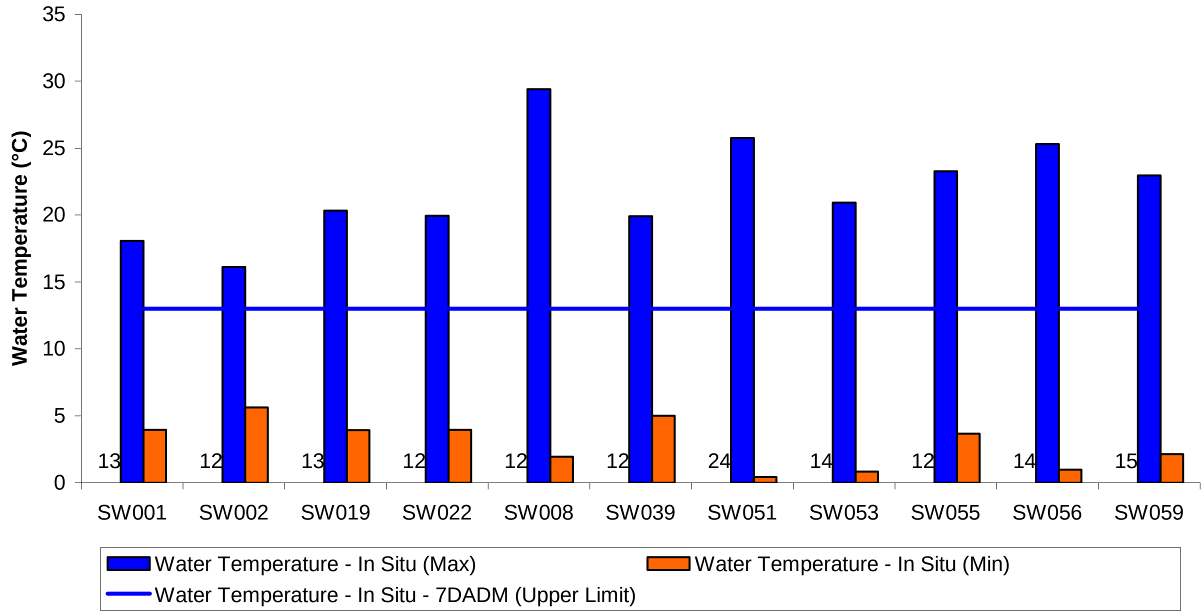

Figure 6.31 Class AA Marine Water Temperature Results Compared With Water Quality Standards: 2009

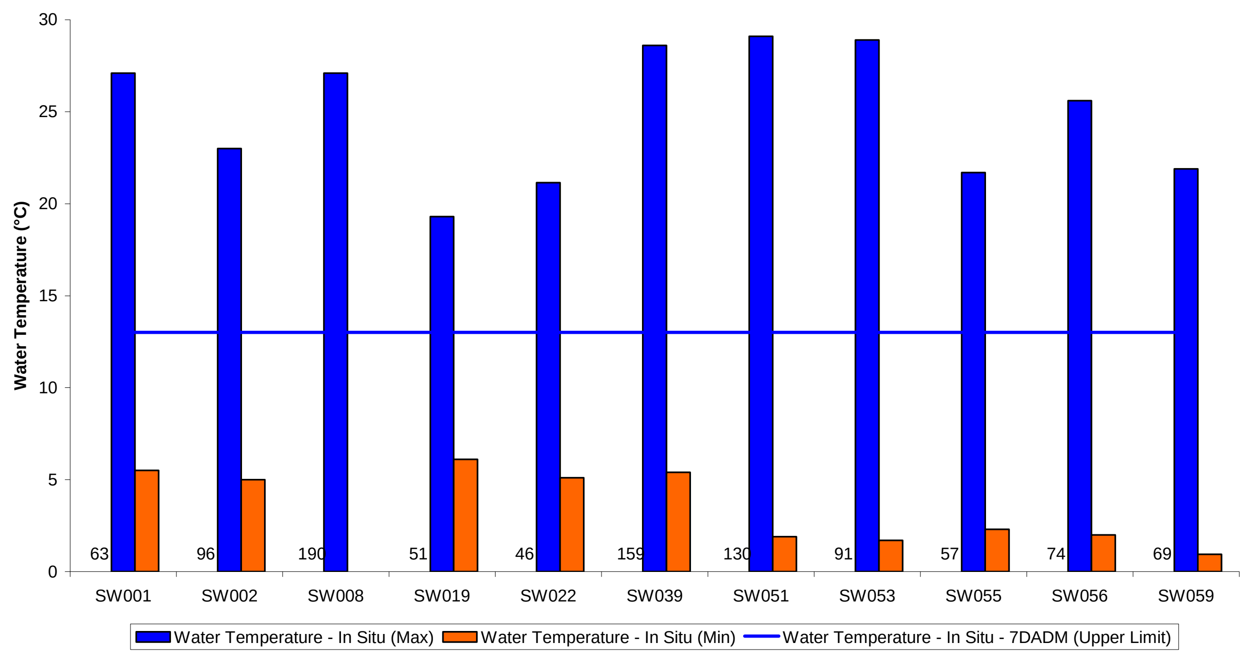

Figure 6.32 Class AA Marine Water Temperature Results Compared With Water Quality Standards: Period of Record through 2008

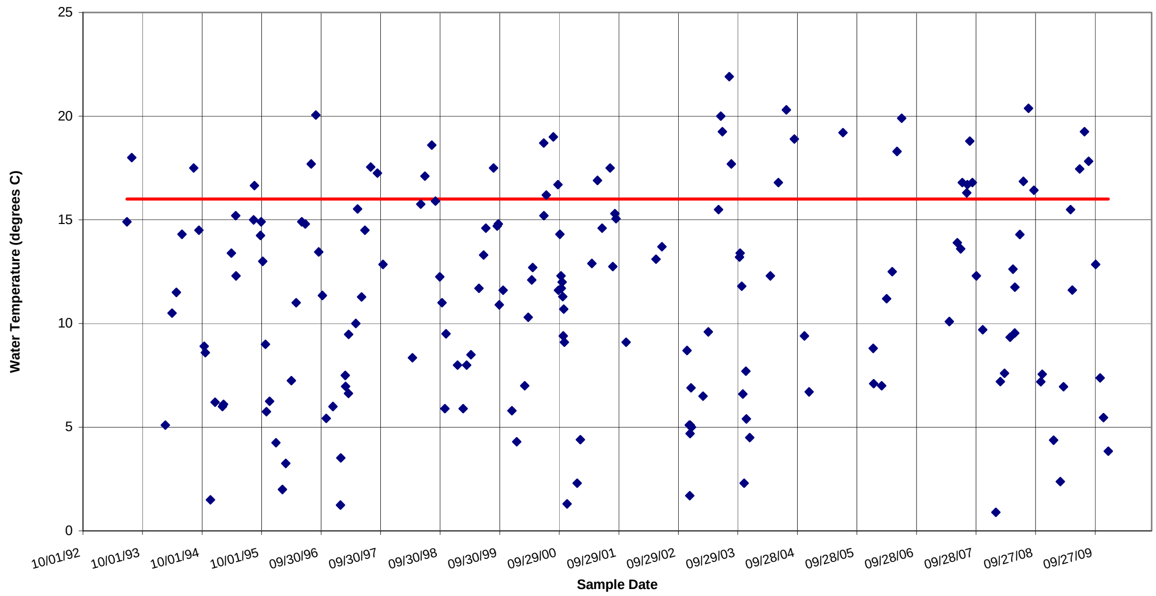

Figure 6.33 Class AA Fresh Water Temperature Results, Site SW009

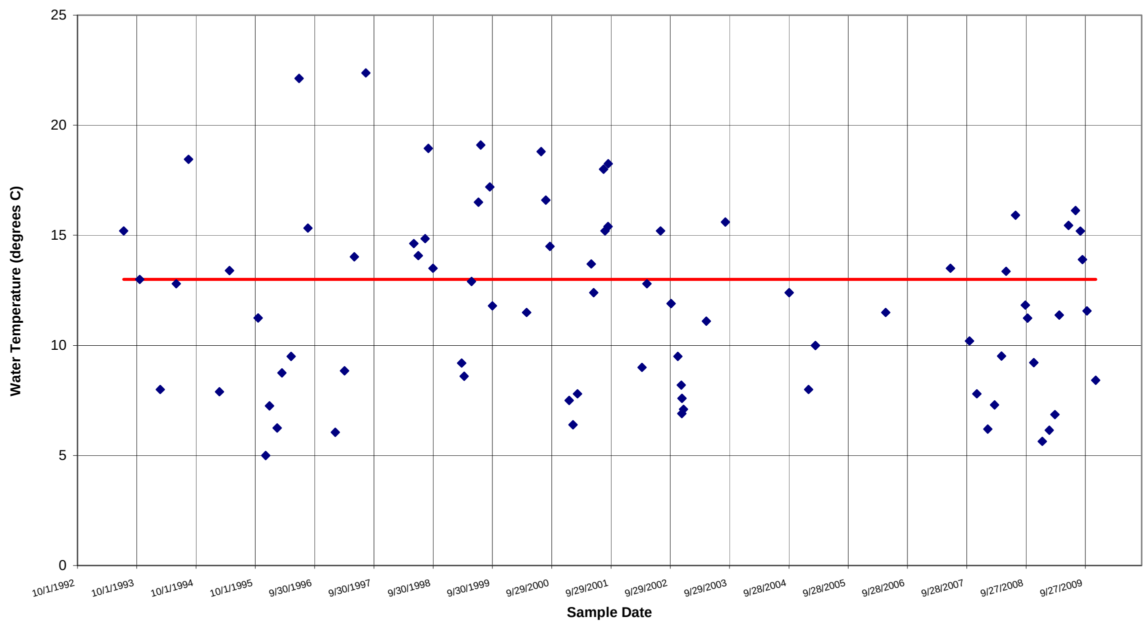

Figure 6.34 Class AA Marine Water Temperature Results, Site SW002

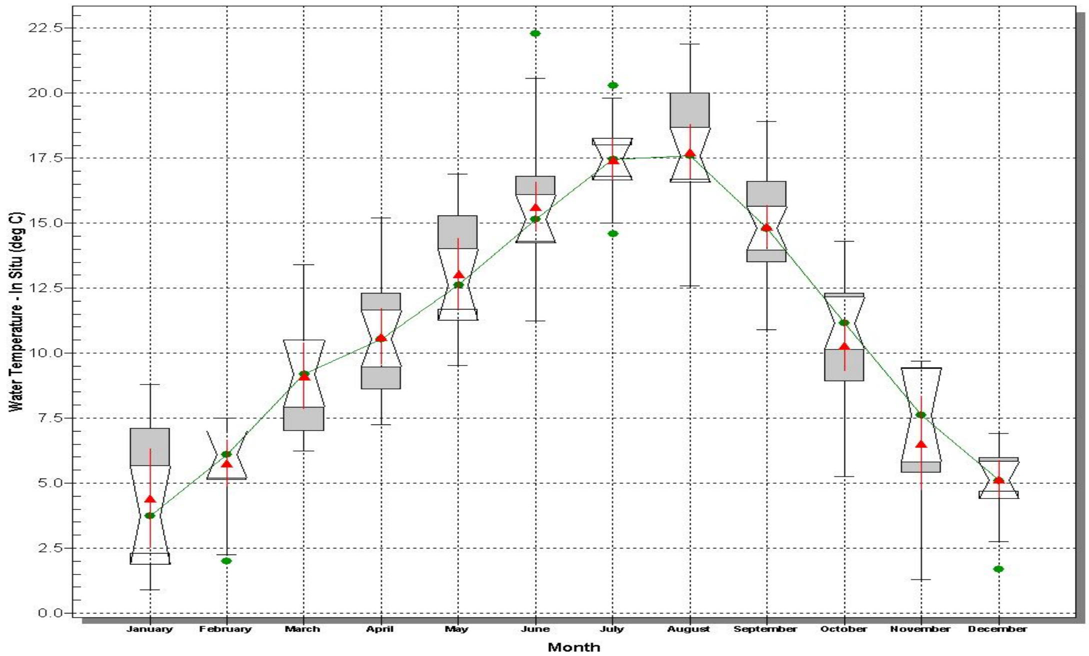

Figure 6.35 Monthly Temperature Variation for Period of Record, Site SW009

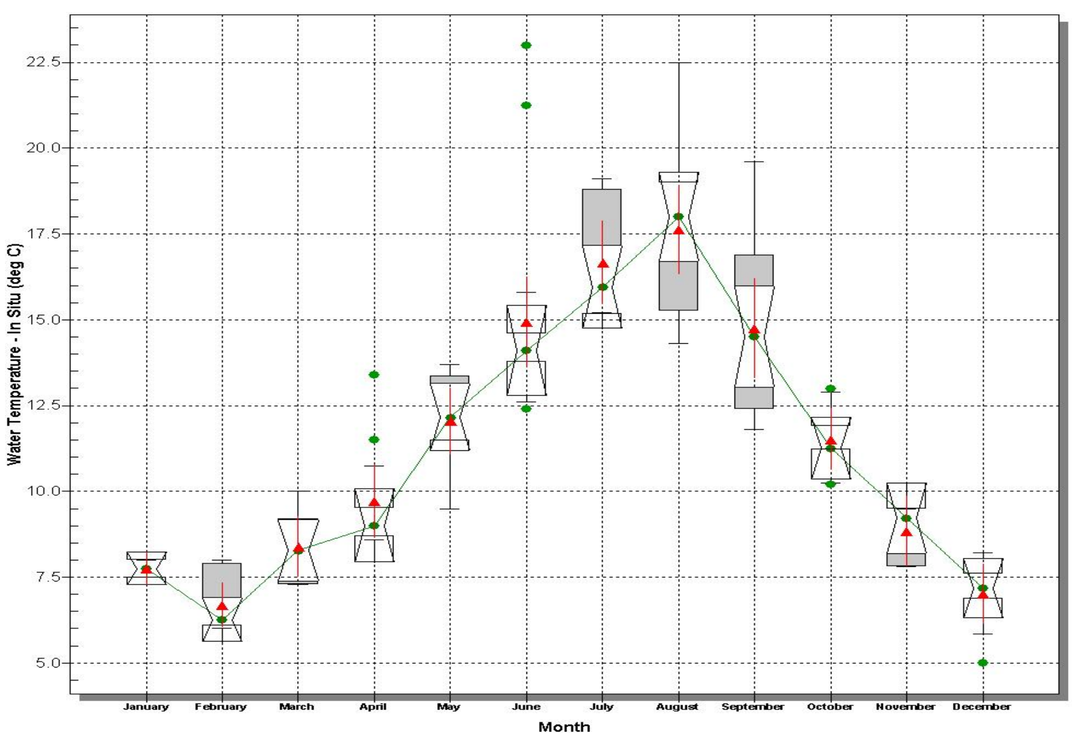

Figure 6.36 Monthly Temperature Variation for Period of Record, Site SW002

6.4.2. Class A Waters

The Class A fresh water quality standard for water temperature is a 7-day average of the daily maximum value (7DADM) of 17.5°C. As shown in Figure 6.37, the water quality data collected during 2009 suggest that this standard was achieved at 6 of the 9 sample sites. Although sample sites SW024 and SW025 are shown in Figure 6.37 to have met the temperature standard during 2009, these results are from only one sample. As shown in Figure 6.38, the water temperature was always below the standard at two of the Class A fresh water monitoring sites (SW024 and SW025). Both of these sites are in a largely forested watershed that drains a portion of Portage Island and are sites that are sampled infrequently due to limited flowing water.

The Class A marine water quality standard for water temperature is a 1-day maximum temperature of 16.0°C. As shown in Figure 6.39, the water quality collected during 2009 suggests that this standard was not achieved at any of the Class A marine water quality sample sites. As shown in Figure 6.39 and Figure 6.40, the water temperature exceeded the standard at least once at all of the Class A marine water quality monitoring sites during both 2009 and over the period of record through 2008.

As shown in Figure 6.41, the water temperature sample results for the representative Class AA fresh water site that contributes to a Class A marine water site (SW018 and SW118 on the Nooksack River along the Reservation boundary) have generally been below the 16.0° C Class AA threshold over the period of record. However, in the last year water temperatures above the standard have become more frequent. As shown in Figure 6.42, the water temperature sample results for the representative Class A marine water site (SW030 in Bellingham Bay) have also generally been below the 16.0°C Class A criterion over the period of record. Site SW030 is located on the tide flats of Bellingham Bay, which at this location are not as extensive as the tide flats of Lummi Bay near Site SW002. However, similar to Site SW002, the water temperature increases as the tidal waters flow over the mud flats and there does not appear to be an anthropogenic cause for the elevated water temperatures observed at this location.

As shown in Figure 6.43, the water temperature at Site SW118 varies during the year with the highest temperatures occurring during July and August and the lowest temperatures during December through February. As shown in Figure 6.44, a similar pattern occurs at Site SW030.

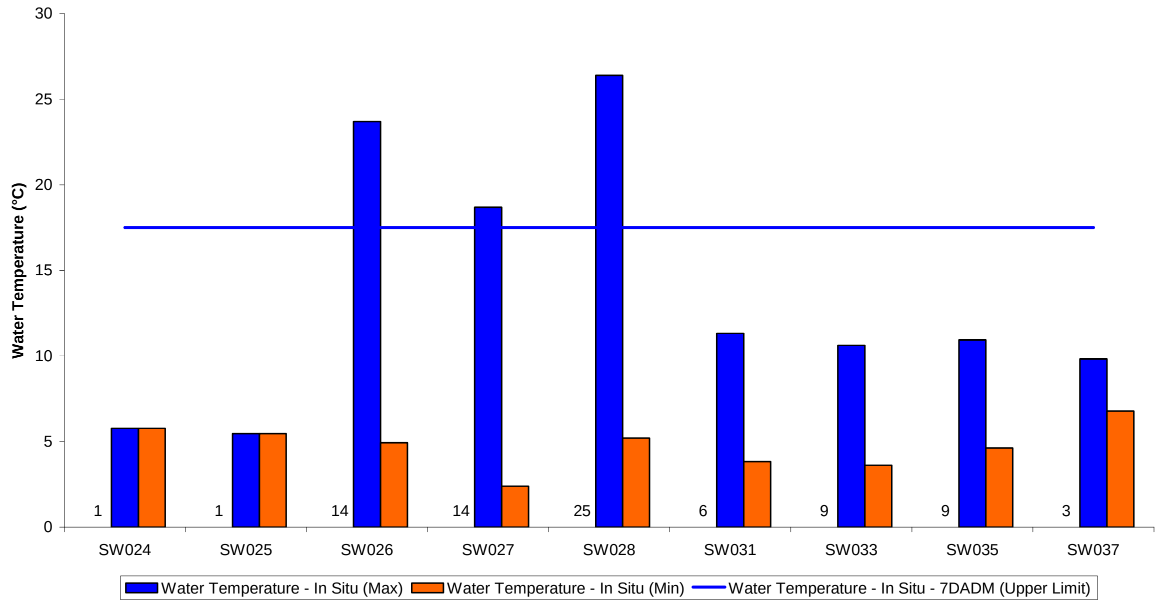

Figure 6.37 Class A Fresh Water Temperature Results Compared With Water Quality Standards: 2009

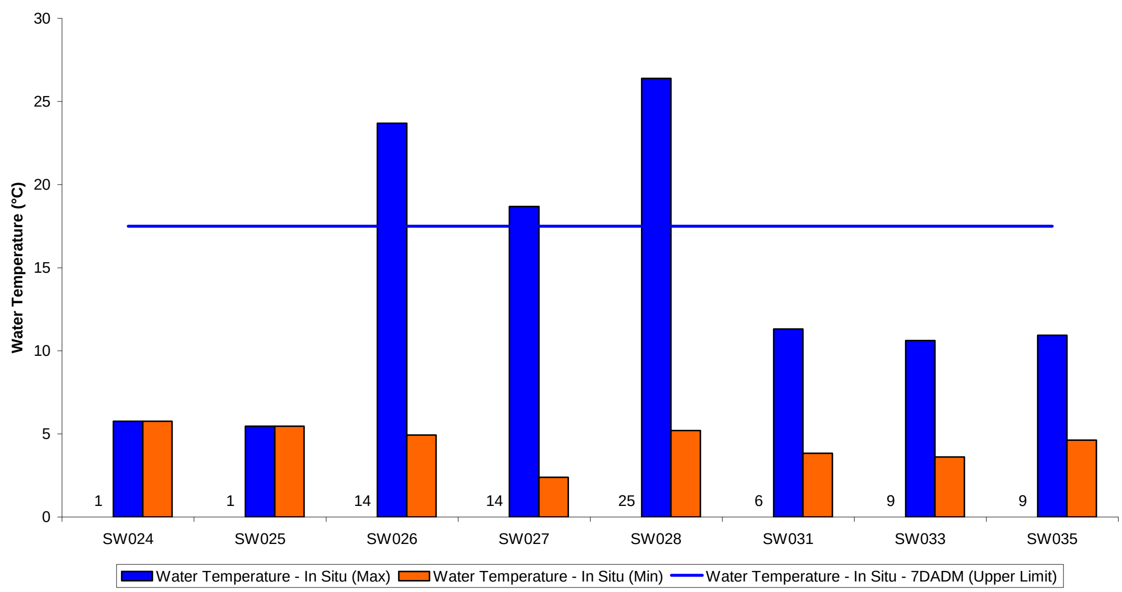

Figure 6.38 Class A Fresh Water Temperature Results Compared With Water Quality Standards: Period of Record through 2008

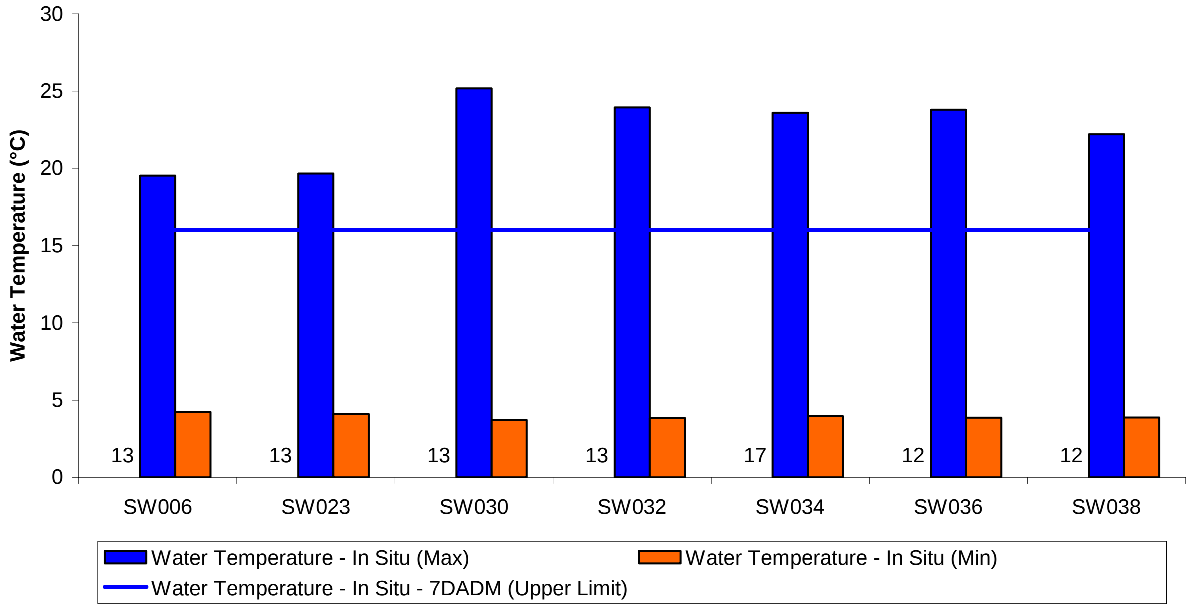

Figure 6.39 Class A Marine Water Temperature Results Compared With Water Quality Standards: 2009

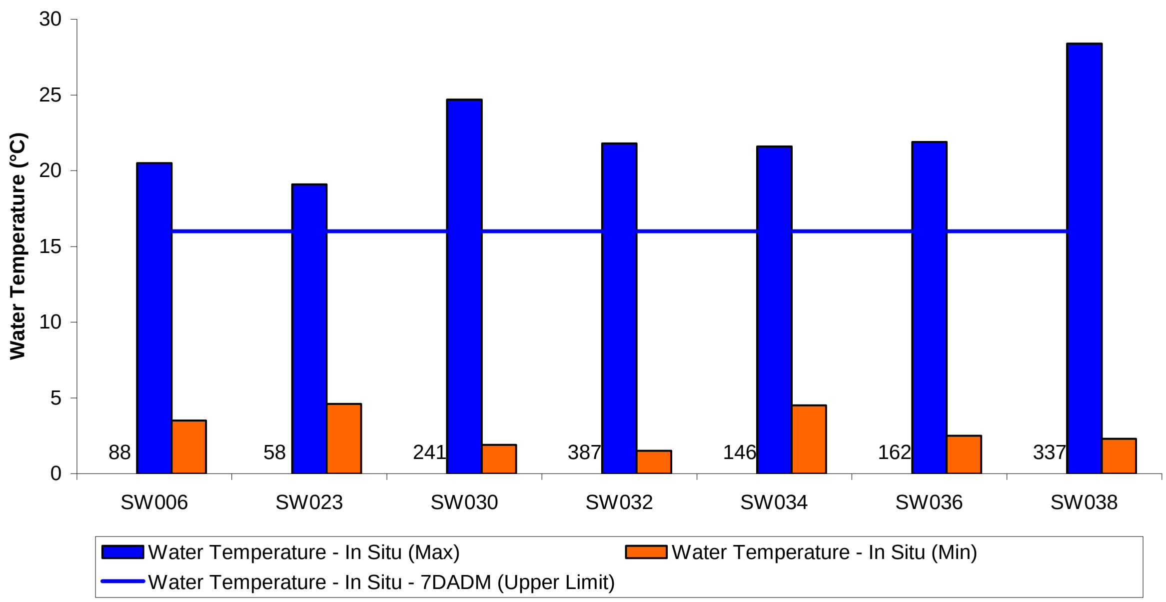

Figure 6.40 Class A Marine Water Temperature Results Compared With Water Quality Standards: Period of Record through 2008

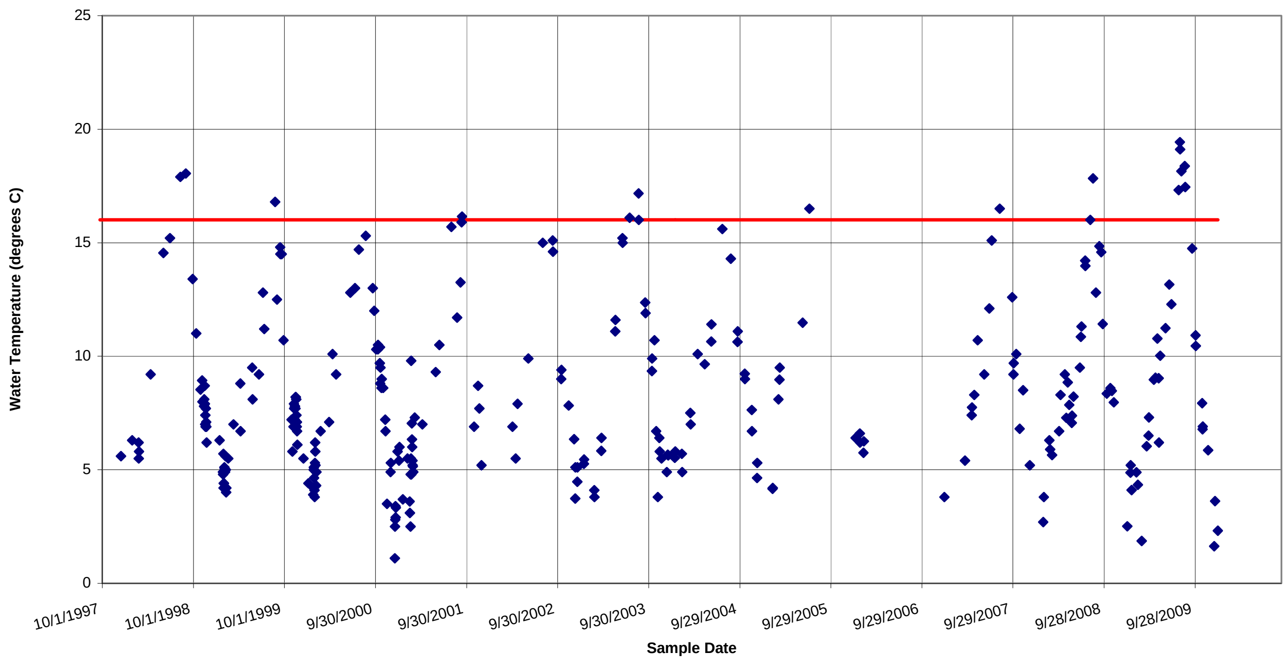

Figure 6.41 Class AA Fresh Water Temperature Results, Site SW018/SW118

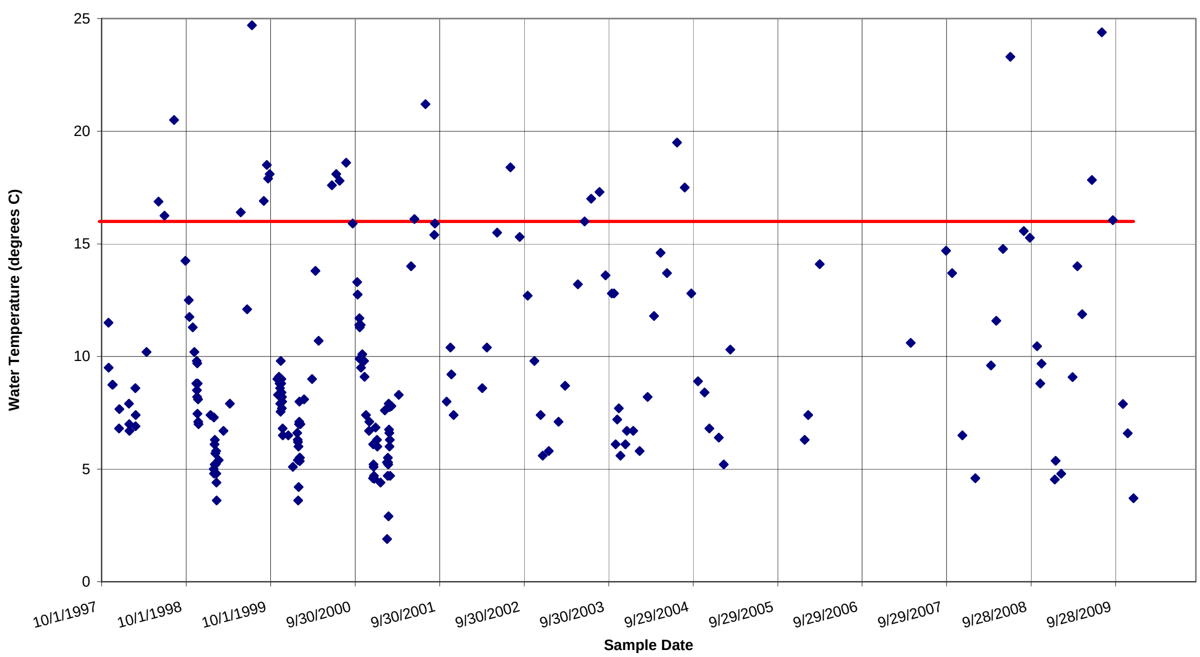

Figure 6.42 Class A Marine Water Temperature Results, Site SW030

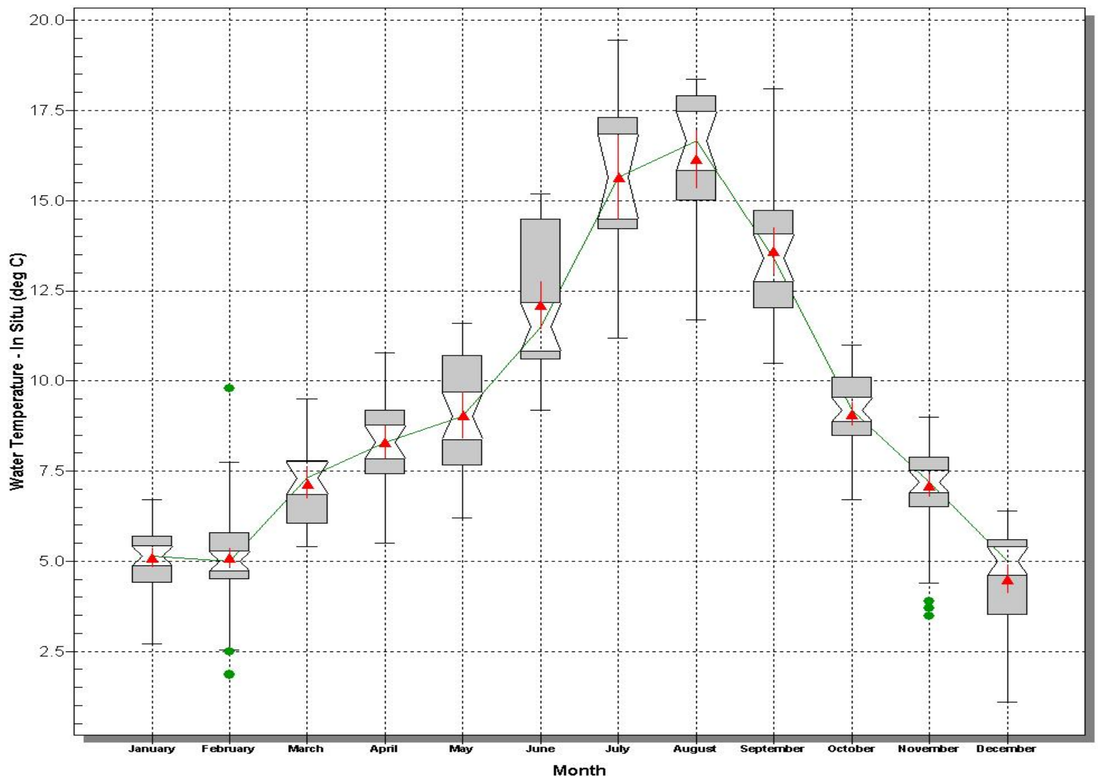

Figure 6.43 Monthly Temperature Variation for Period of Record, Site SW018/SW118

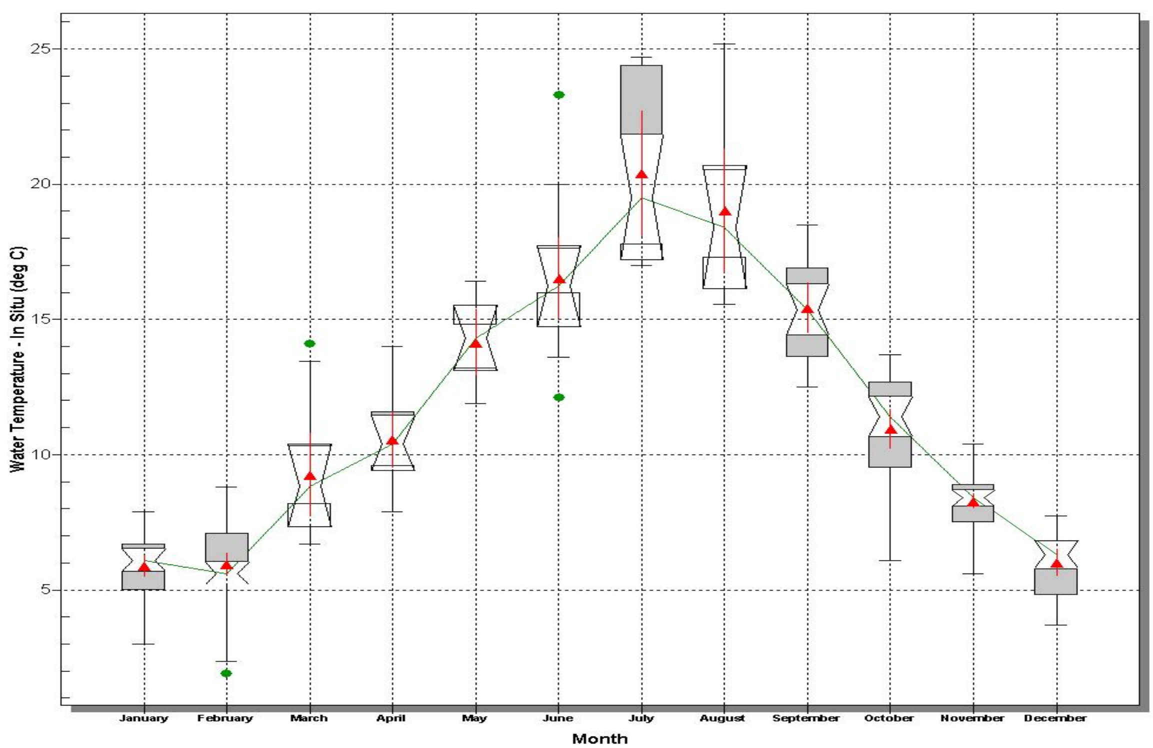

Figure 6.44 Monthly Temperature Variation for Period of Record, Site SW030

6.5. Dissolved Oxygen Results

In contrast to the bacteria and water temperature criteria, the water quality standards for dissolved oxygen are a minimum value. If the maximum or minimum measured dissolved oxygen levels are less than the water quality standard, the sample results suggest that the characteristic uses of the water body are not supported. The spatial median intergravel dissolved oxygen concentration is currently not measured at the sample sites so it is not possible to determine compliance with the water quality standards for Class AA fresh water sites.

6.5.1. Class AA Waters

The Class AA fresh water quality standard for dissolved oxygen is a minimum of 11.0 mg/l and a spatial median intergravel dissolved oxygen concentration greater than 8.0 mg/l. The spatial median intergravel dissolved oxygen concentration is currently not measured at the sample sites so it is not possible to determine compliance with the water quality standards for Class AA fresh water sites. As shown in Figure 6.45, the water quality data collected during 2009 suggest that the 11.0 mg/l part of the standard was achieved at least once for 13 of the 16 sample sites and not achieved at the three remaining sites. Although Site SW018 is shown in Figure 6.45 to have met the dissolved oxygen standard during 2009, this result is from only one sample. As shown in Figure 6.46, the dissolved oxygen levels have been above the 11.0 mg/l criterion at least once at every site except for Site SW072, where dissolved oxygen has never been measured above the 11.0 mg/l criterion. Site SW072 is a remnant of a slough in the Nooksack River/Lummi River floodplain.

The Class AA marine water quality standard for dissolved oxygen is a 1-day minimum daily concentration of 7.0 mg/l. As shown in Figure 6.47, the water quality data collected during 2009 suggest that this standard was achieved at least once at all 11 of the sample sites. Sites SW002, SW022, and SW039 were consistently above the standard during 2009. As shown in Figure 6.48, the dissolved oxygen standard was consistently achieved over the period of record at Site SW039 of the Class AA marine water monitoring sites, which is located along Hale Passage.

As shown in Figure 6.49, the dissolved oxygen sample results for the representative Class AA fresh water site that contributes to a Class AA marine water site (SW009) have generally been below the minimum 11.0 mg/l criterion over the period of record. In contrast, as shown in Figure 6.50, the dissolved oxygen sample results for the representative Class AA marine water site (SW002) have commonly been above the 7.0 mg/l criterion over the period of record.

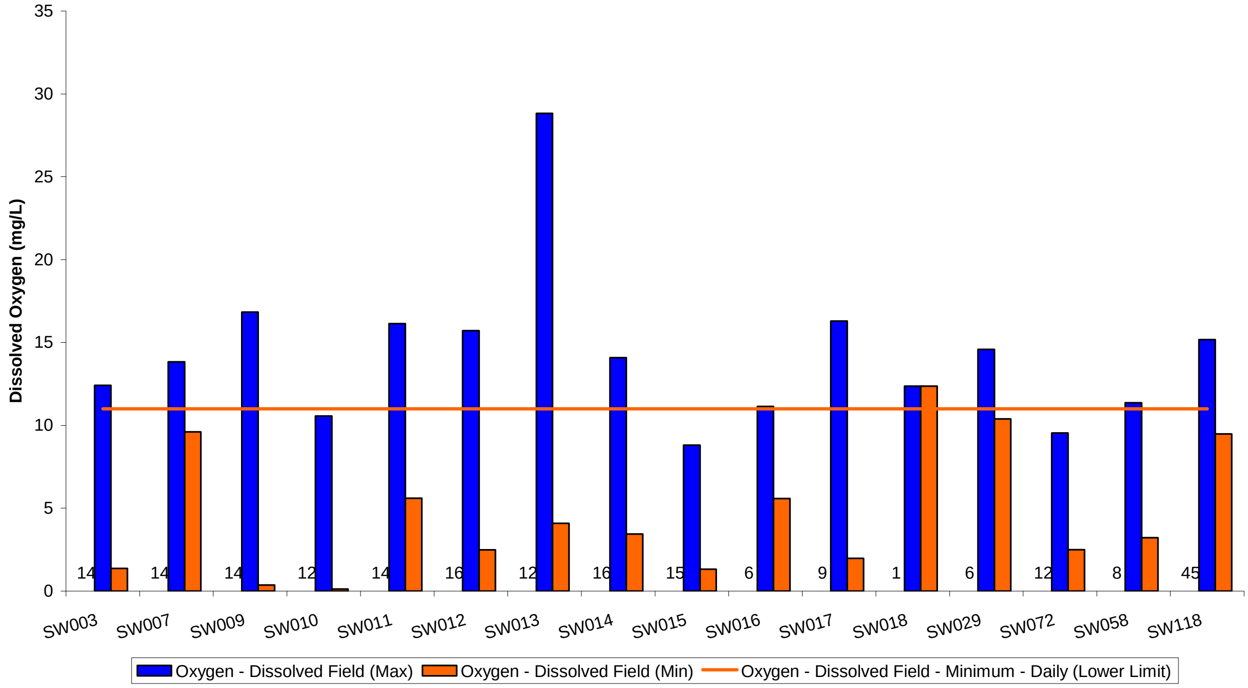

Figure 6.45 Class AA Fresh Water Dissolved Oxygen Results Compared with Water Quality Standards: 2009

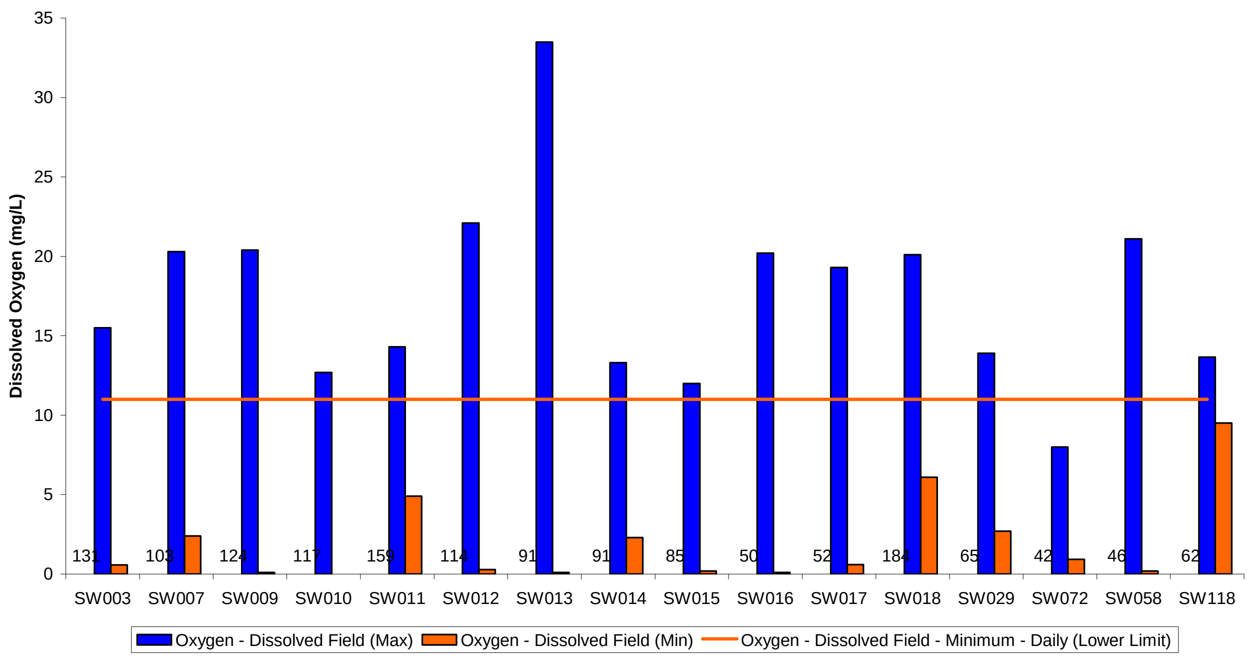

Figure 6.46 Class AA Fresh Water Dissolved Oxygen Results Compared with Water Quality Standards: Period of Record through 2008

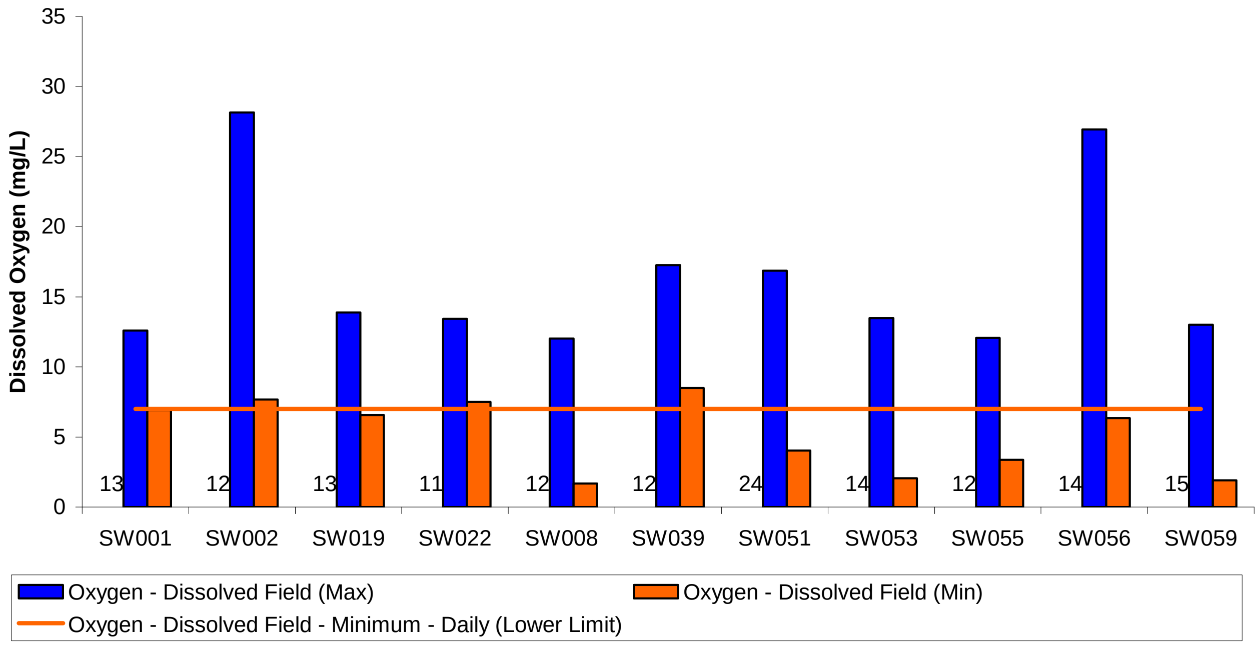

Figure 6.47 Class AA Marine Water Dissolved Oxygen Results Compared with Water Quality Standards: 2009

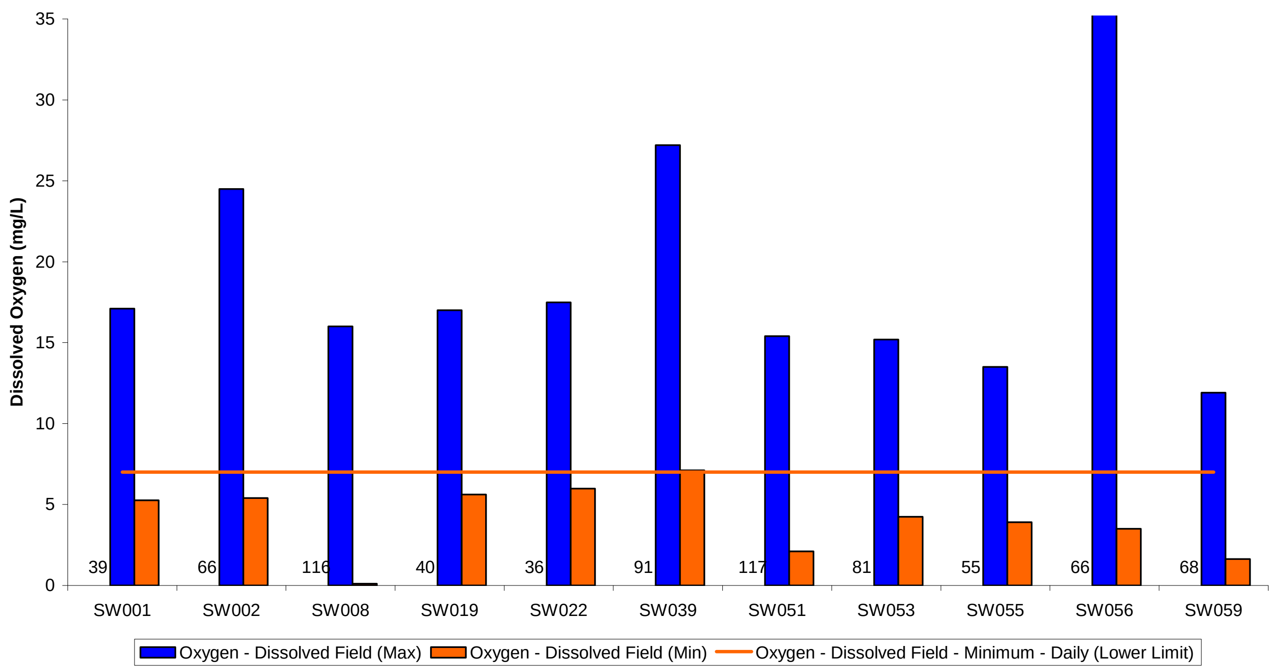

Figure 6.48 Class AA Marine Water Dissolved Oxygen Results Compared with Water Quality Standards: Period of Record through 2008

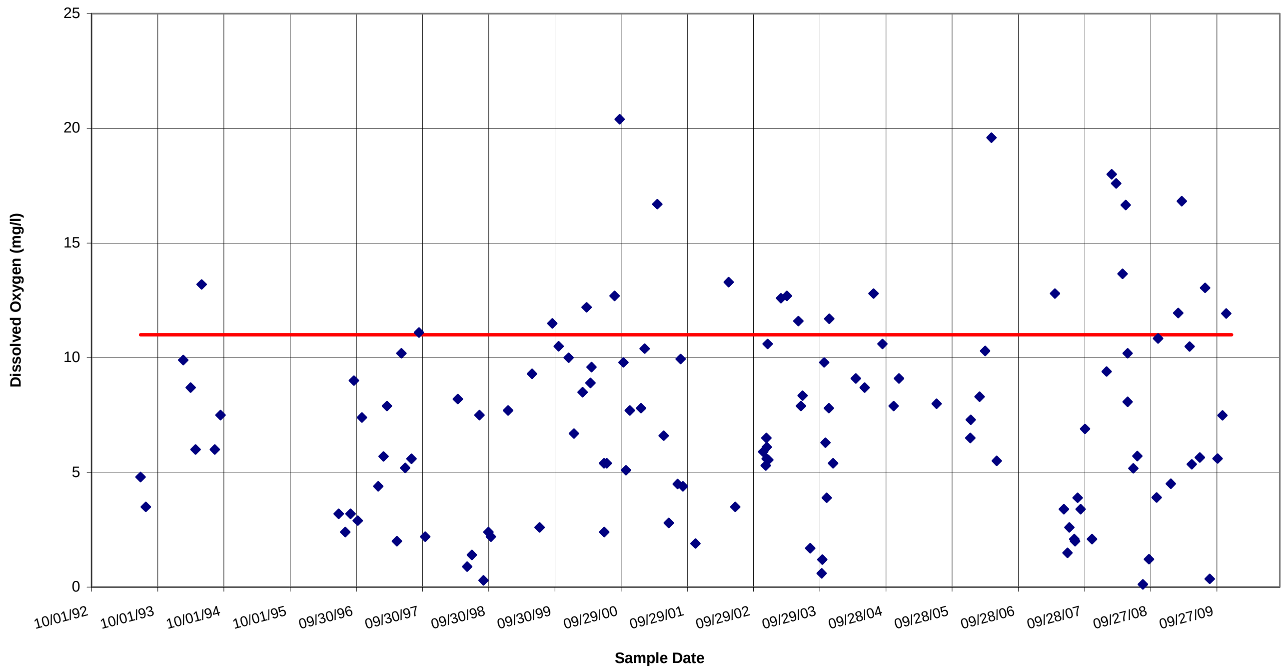

Figure 6.49 Class AA Fresh Water Dissolved Oxygen Results, Site SW009

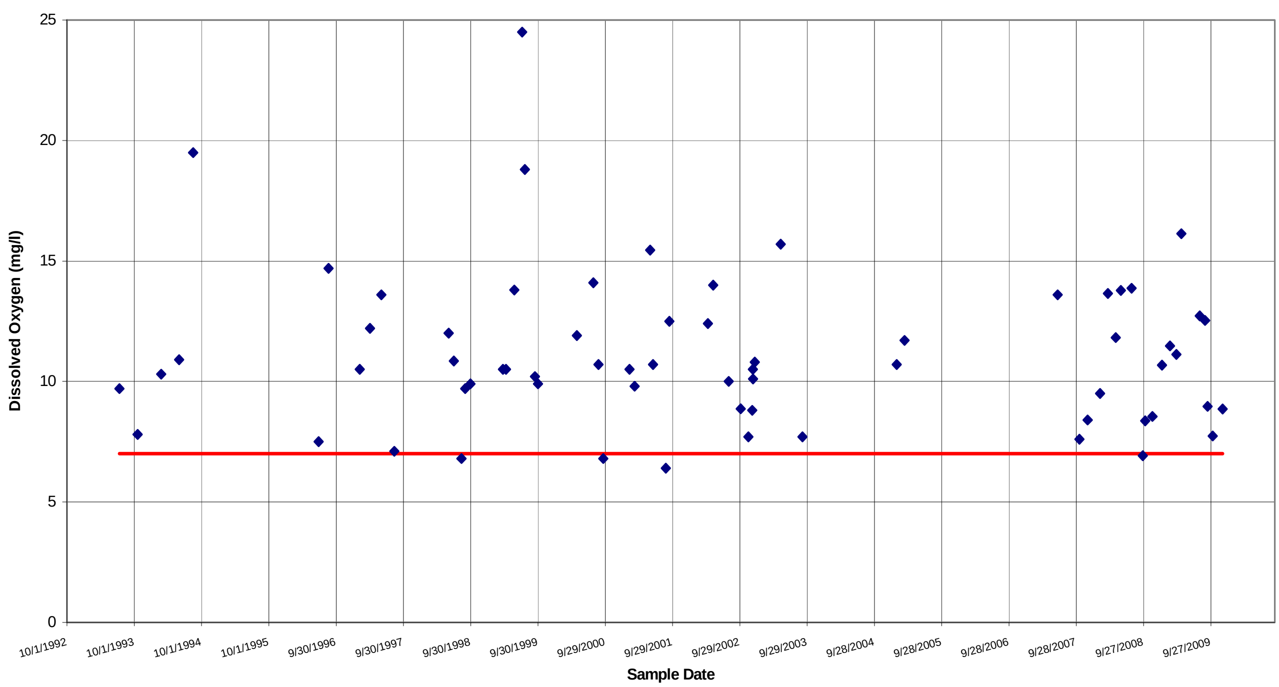

Figure 6.50 Class AA Marine Water Dissolved Oxygen Results, Site SW002

6.5.2. Class A Waters

The Class A fresh water quality standard for dissolved oxygen is a minimum value of 8.0 mg/l. As shown in Figure 6.51, the water quality samples collected during 2009 suggest that this standard was achieved at 5 of the 9 sample sites. Although sites SW024, SW025, and SW037 are shown in Figure 6.51 to have met the standard, the results were from only one to three samples at each site. As shown in Figure 6.52, the dissolved oxygen was above the minimum standard at least one time at the nine Class A fresh water monitoring sites over the period of record through 2008. Although Site SW024 is shown to have met the standard during the period of record, this result reflects only one sample.

The Class A marine water quality standard for dissolved oxygen is a 1-day minimum concentration of 6.0 mg/l. As shown in Figure 6.53, the dissolved oxygen levels were above the 6.0 mg/l criterion during 2009 at all seven sites. As shown in Figure 6.54, the dissolved oxygen levels consistently exceeded the standard at all of the Class A marine water quality monitoring sites except Site SW030 over the period of record through 2008.

As shown in Figure 6.55, the dissolved oxygen sample results for the representative Class AA fresh water site that contributes to a Class A marine water site (SW018 and SW118 on the Nooksack River along the Reservation boundary) have generally been above the minimum 11.0 mg/l Class AA threshold over the period of record. As shown in Figure 6.56, all the dissolved oxygen sample results except one in 2008 for the representative Class A marine water site (SW030 in Bellingham Bay) were above the minimum 6.0 mg/l Class A threshold over the period of record.

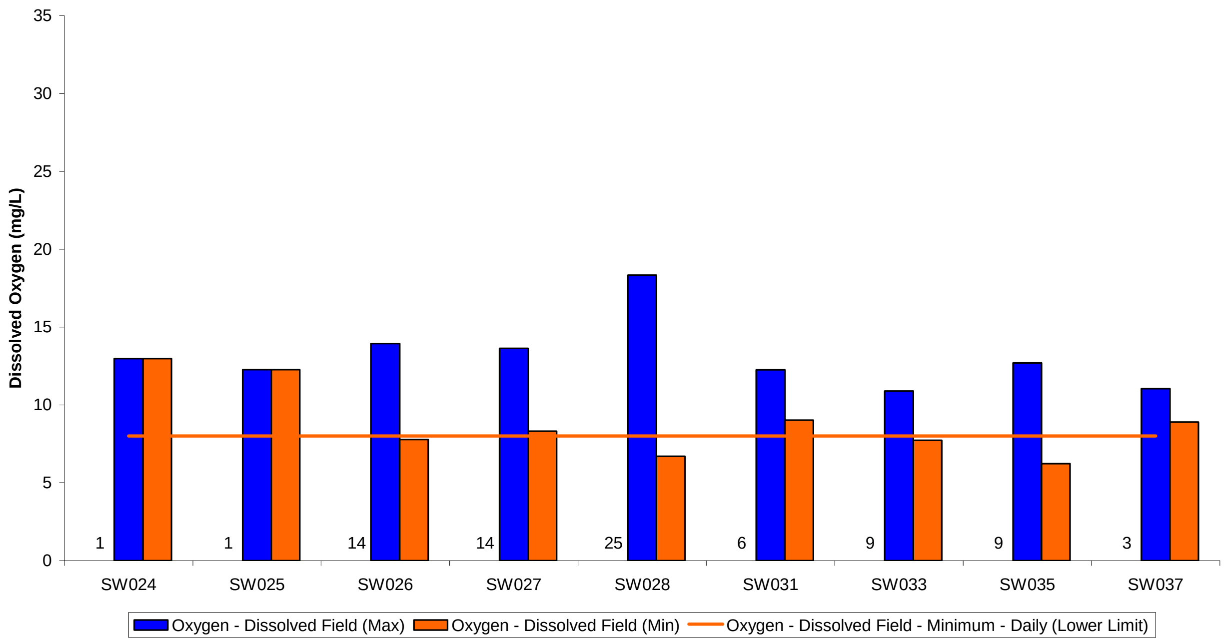

Figure 6.51 Class A Fresh Water Dissolved Oxygen Results Compared With Water Quality Standards: 2009

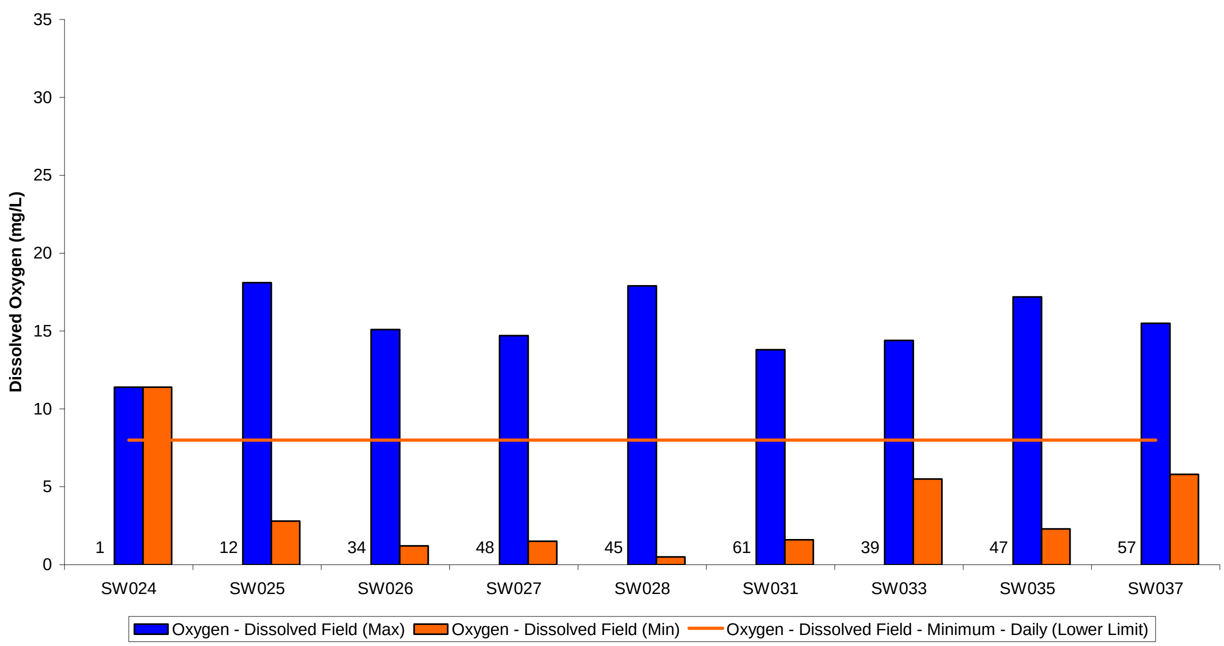

Figure 6.52 Class A Fresh Water Dissolved Oxygen Results Compared With Water Quality Standards: Period of Record through 2008

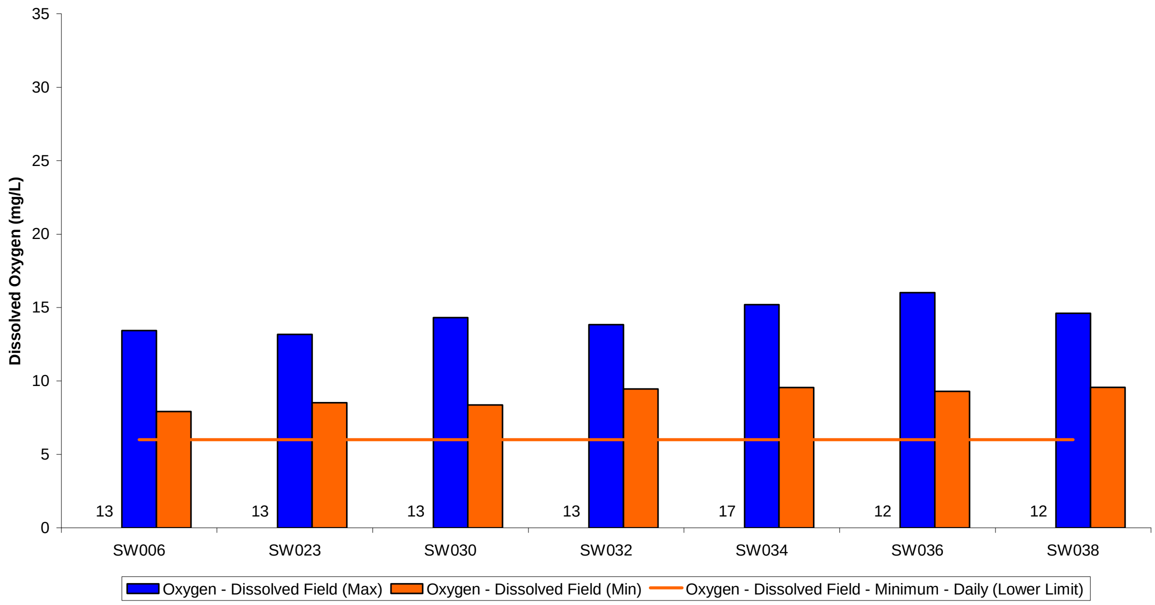

Figure 6.53 Class A Marine Water Dissolved Oxygen Results Compared With Water Quality Standards: 2009

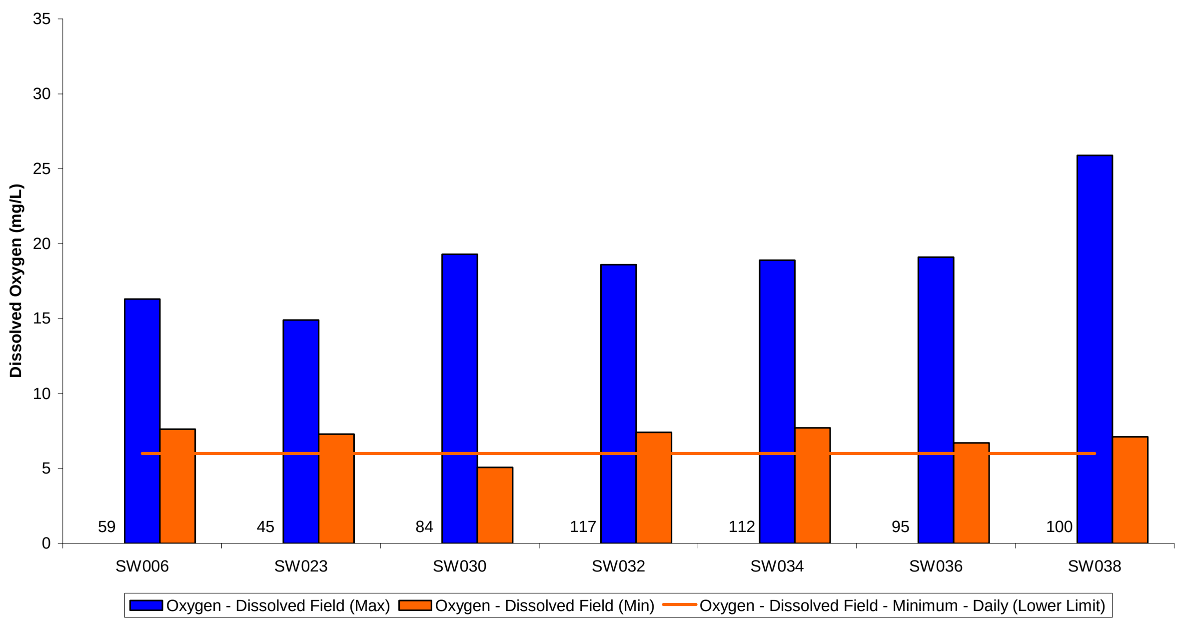

Figure 6.54 Class A Marine Water Dissolved Oxygen Results Compared With Water Quality Standards: Period of Record through 2008

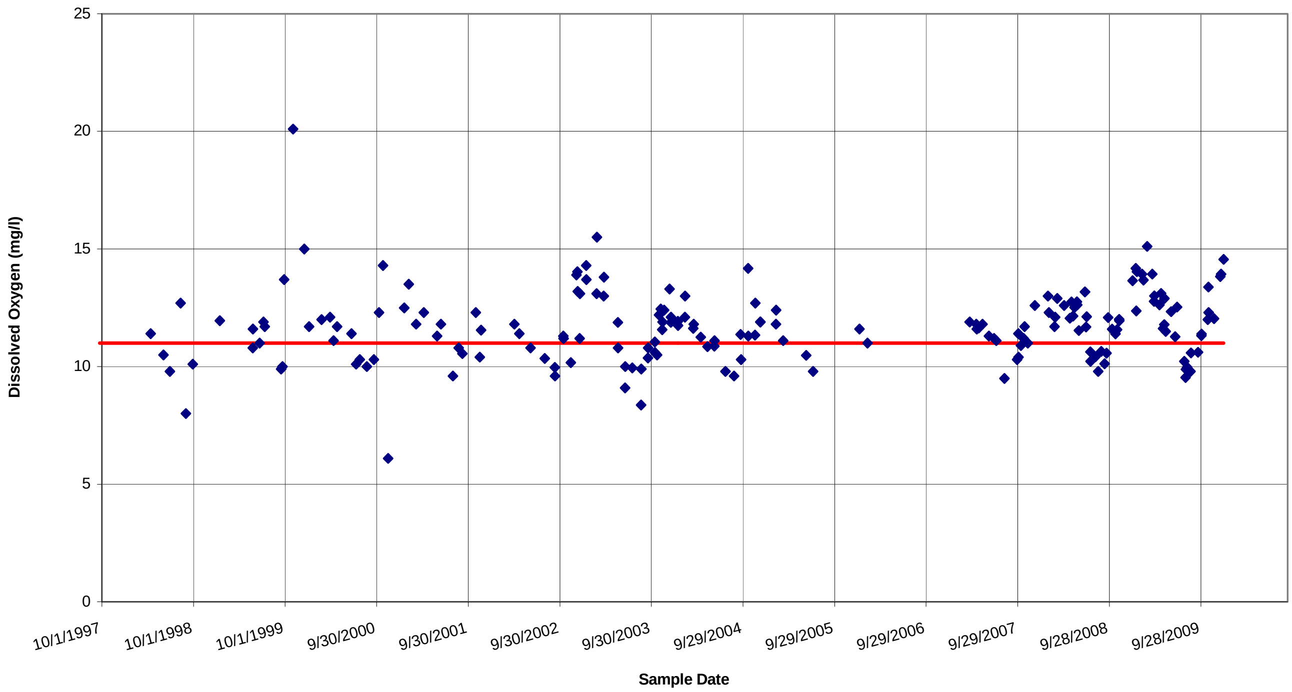

Figure 6.55 Class AA Fresh Water Dissolved Oxygen Results, Site SW018/SW118

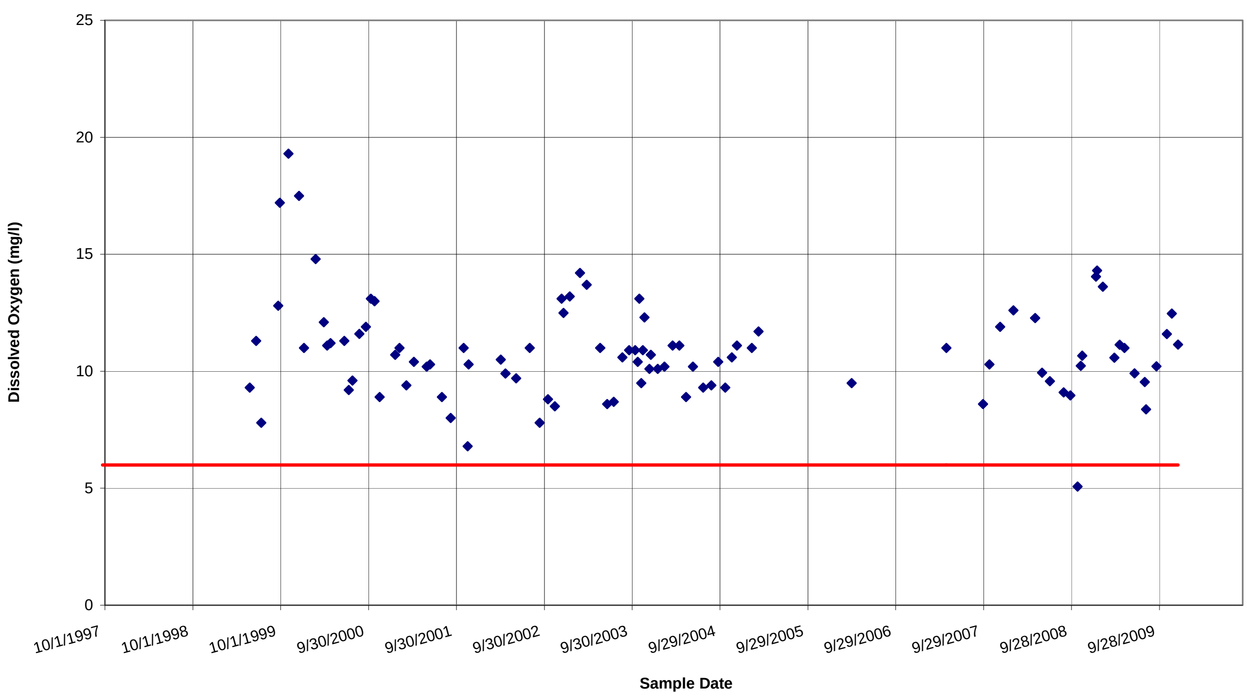

Figure 6.56 Class A Marine Water Dissolved Oxygen Results, Site SW030

6.5.3. Relationship between Dissolved Oxygen and Temperature

Water temperature influences the concentration of dissolved oxygen in a water body. In general, cold water can hold more oxygen than warm water. Adequate concentrations of dissolved oxygen are necessary for the health of fish and other aquatic organisms and to prevent offensive odors caused by anaerobic bacteria. Low dissolved oxygen levels can impact organisms' growth rates, swimming ability, susceptibility to diseases, and the ability to survive other environmental stressors and pollutants.

As summarized in Table 6.5, the relation between temperature and dissolved oxygen varies from site to site and there is generally a poor relationship between the two water chemistry variables. The best relationship, as defined by the highest coefficient of determination (r^2) and slope of the best-fit line close to 1, is for Site SW118 (Nooksack River at Marine Drive).

Table 6.5 Relation Between Dissolved Oxygen and Temperature

Sample Site Number	Number of Sample Pairs	Slope	Intercept	R-Square
Fresh Water				
SW003	177	-0.18	9.70	0.16
SW007	149	-0.29	14.20	0.34
SW009	169	-0.18	9.13	0.04
SW010	159	-0.20	7.58	0.11
SW011	308	-0.30	13.43	0.30
SW012	183	-0.18	9.17	0.08
SW013	123	0.54	1.38	0.23
SW014	150	-0.49	13.31	0.57
SW015	120	0.08	4.81	0.02
SW016	64	0.02	7.94	0.00
SW017	70	0.17	5.69	0.05
SW018	240	-0.23	13.66	0.37
SW025	13	0.61	5.94	0.28
SW026	75	-0.04	11.03	0.01
SW027	101	-0.34	13.95	0.32
SW028	117	-0.20	14.38	0.13
SW029	89	-0.42	13.95	0.43
SW032	136	-0.06	11.60	0.02
SW034	151	-0.06	11.55	0.02
SW036	108	-0.10	12.08	0.06
SW038	111	-0.12	12.32	0.07
SW058	58	-0.29	9.93	0.05
SW072	59	-0.01	4.19	0.00
SW118	156	-0.26	14.40	0.76
Marine Water				
SW001	73	0.05	8.93	0.01
SW002	118	0.07	10.46	0.01
SW006	100	-0.12	11.87	0.12
SW008	153	-0.20	10.18	0.27
SW022	62	-0.12	11.57	0.05
SW023	76	-0.16	12.02	0.17
SW030	96	-0.16	12.73	0.15
SW031	90	-0.17	11.58	0.08
SW033	58	-0.07	9.68	0.04
SW035	64	0.07	8.96	0.01
SW037	70	-0.17	11.39	0.15
SW039	112	0.22	8.20	0.09
SW051	145	-0.12	10.90	0.15
SW053	113	-0.14	11.01	0.18
SW055	67	-0.09	9.08	0.06
SW059	105	-0.20	9.07	0.20

6.6. pH Results

The water quality standards for pH (hydrogen ion concentration) set a range of acceptable values. If the maximum or minimum measured pH is not within the specified range, the sample results indicate that the characteristic uses of the water body are not supported.

6.6.1. Class AA Waters

The Class AA fresh water quality standard for pH is not less than 6.5 and not more than 8.5. As shown in Figure 6.57, the water quality data collected during 2009 indicate that the pH standard was achieved at 7 of the 16 sample sites. Although Site SW018 is shown in Figure 6.57 to have met the pH standard during 2009, this result is from a single sample. As described above, Site SW018 was moved downstream and the sample site identifier changed to Site SW118. Site SW118 did not meet the pH standard in 2009. As shown in Figure 6.58, the pH standard was always achieved at 2 of the 16 sample sites (SW011 and SW012), over the period of record. The highest pH (most basic) levels were measured at the Nooksack River site (SW018/SW118) and the lowest pH (most acidic) levels were measured within a roadside ditch along Ferndale Road (SW016) along the northeast boundary of the Reservation.

The Class AA marine water quality standard for pH is not less than 7.0 and not more than 8.5. As shown in Figure 6.59, the water quality data collected during 2009 indicate that this standard was achieved at 6 of the 11 sample sites. As shown in Figure 6.60, 10 of the 11 sample sites had at least one sample that had a pH value that was either above or below the 7.0 to 8.5 range over the period of record. Only Site SW019 in the Sandy Point Marina achieved the pH water quality standard over the period of record. The highest pH value was measured at the sample site along the Lummi River at the Hillaire Road Bridge (SW008) and the lowest pH value was measured in Smuggler's Slough in the Nooksack River/Lummi River floodplain (SW059).

As shown in Figure 6.61, the pH sample results for the representative Class AA fresh water site that contributes to a Class AA marine water site (SW009) have generally been more than 6.5 and less than 8.5 units. Figure 6.58 shows that the maximum and minimum pH levels measured over the period of record were more than 8.5 units and less than 6.5 units respectively. However, when there were multiple measurements during a particular day, the results were averaged in the data shown in Figure 6.61.

As shown in Figure 6.62, the pH sample results for the representative Class AA marine water site (SW002) have always been above the 6.5 pH threshold but have exceeded the 8.5 pH units threshold on two occasions over the period of record. Figure 6.61 and Figure 6.62 also show the gap in the pH data record that resulted from a combination of equipment malfunctions and staff changes.

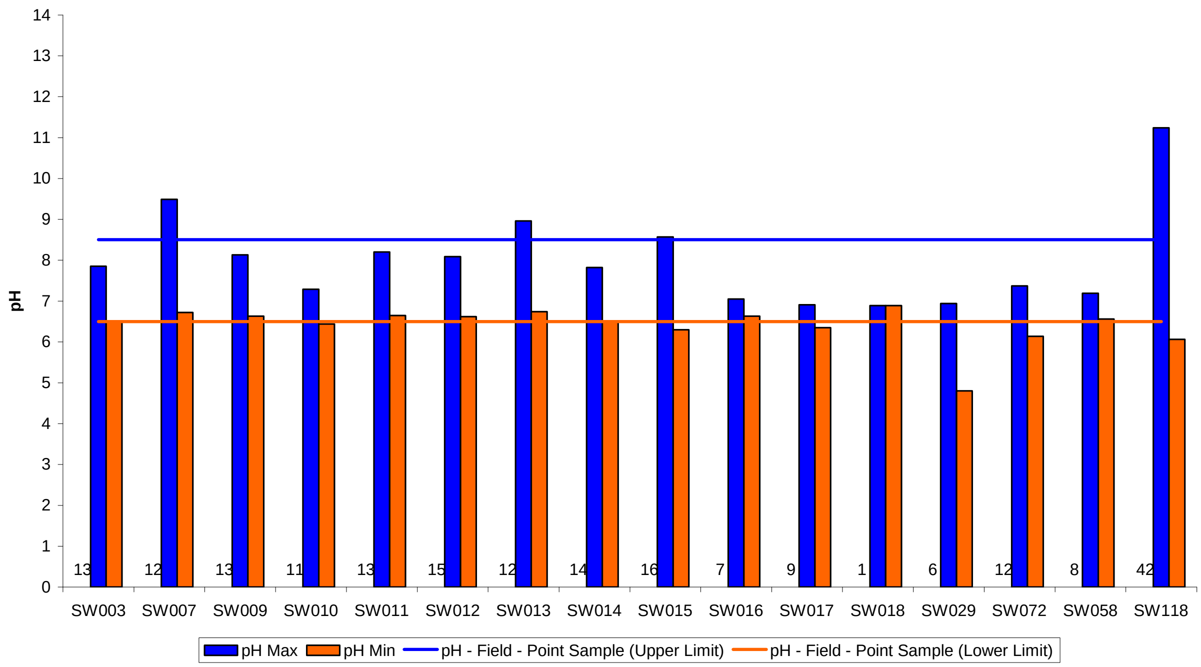

Figure 6.57 Class AA Fresh Water pH Results Compared with Water Quality Standards: 2009

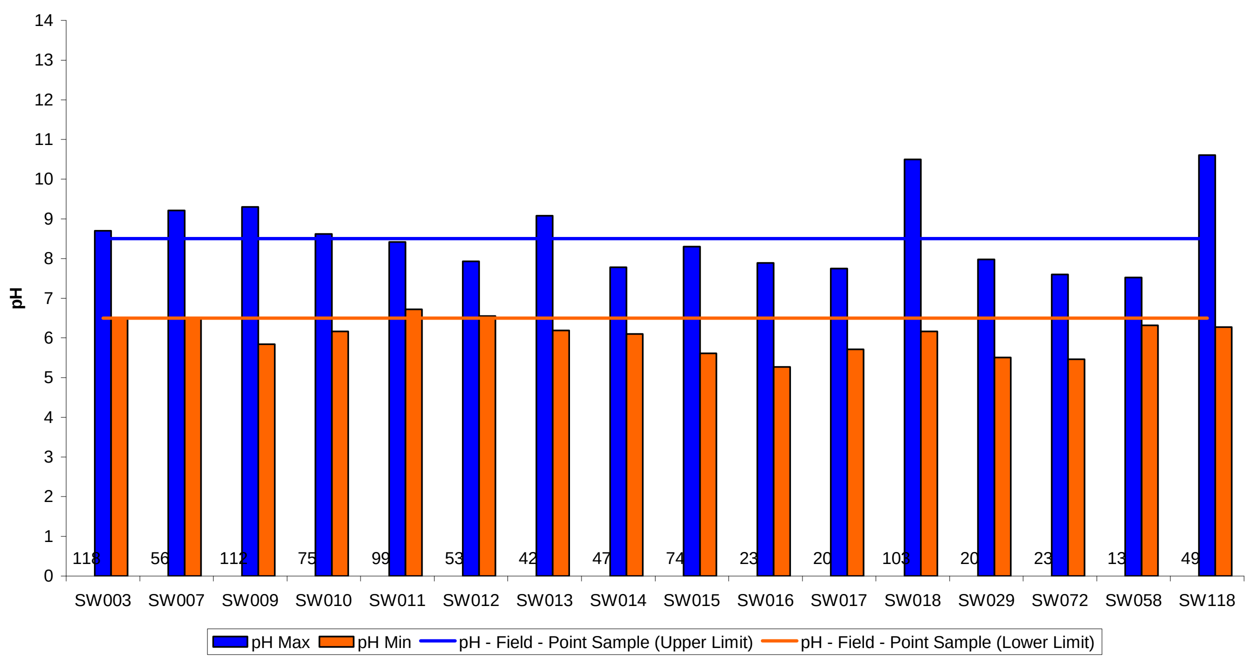

Figure 6.58 Class AA Fresh Water pH Results Compared with Water Quality Standards: Period of Record through 2008

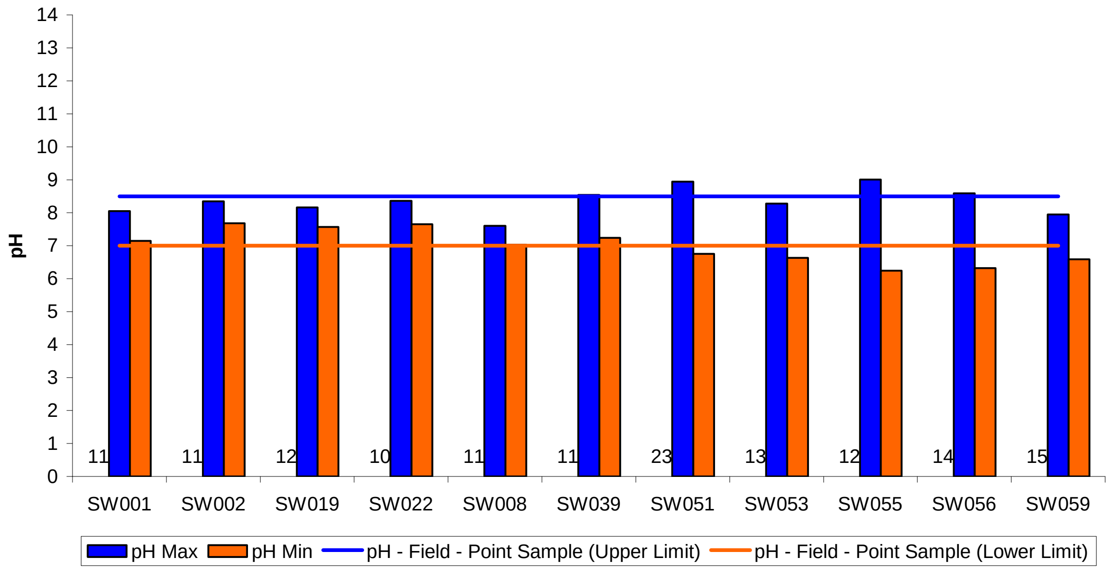

Figure 6.59 Class AA Marine Water pH Results Compared with Water Quality Standards: 2009

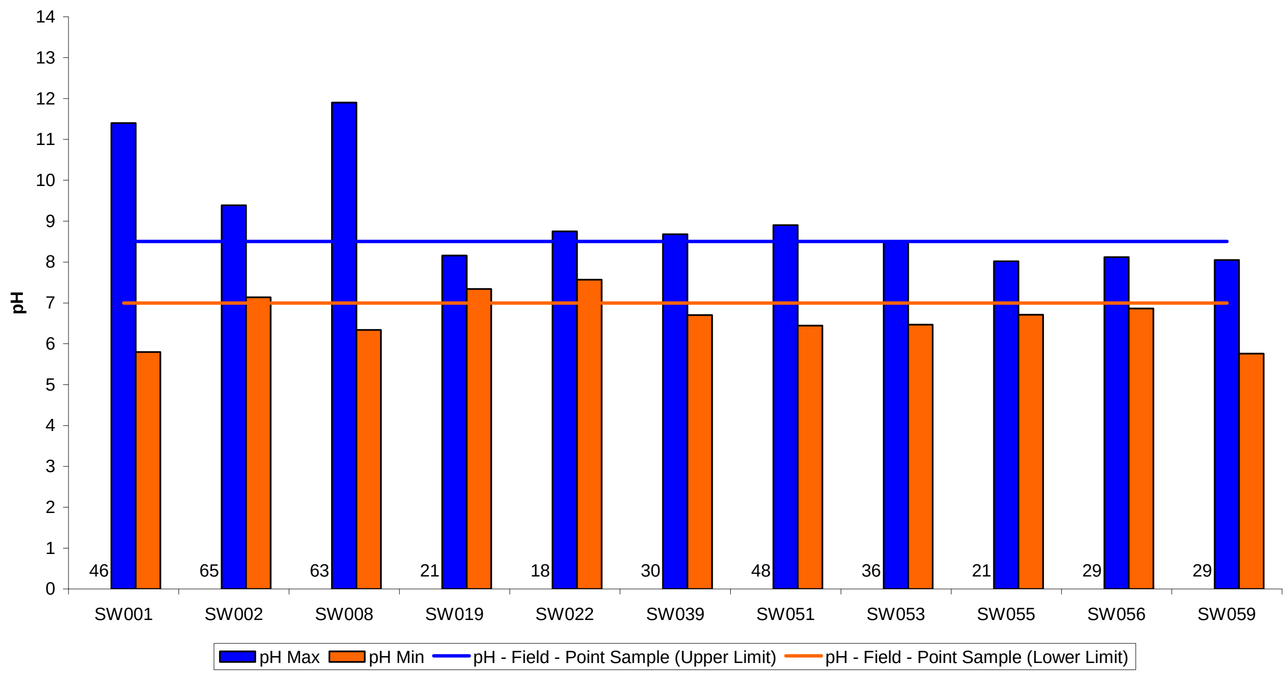

Figure 6.60 Class AA Marine Water pH Results Compared with Water Quality Standards: Period of Record through 2008

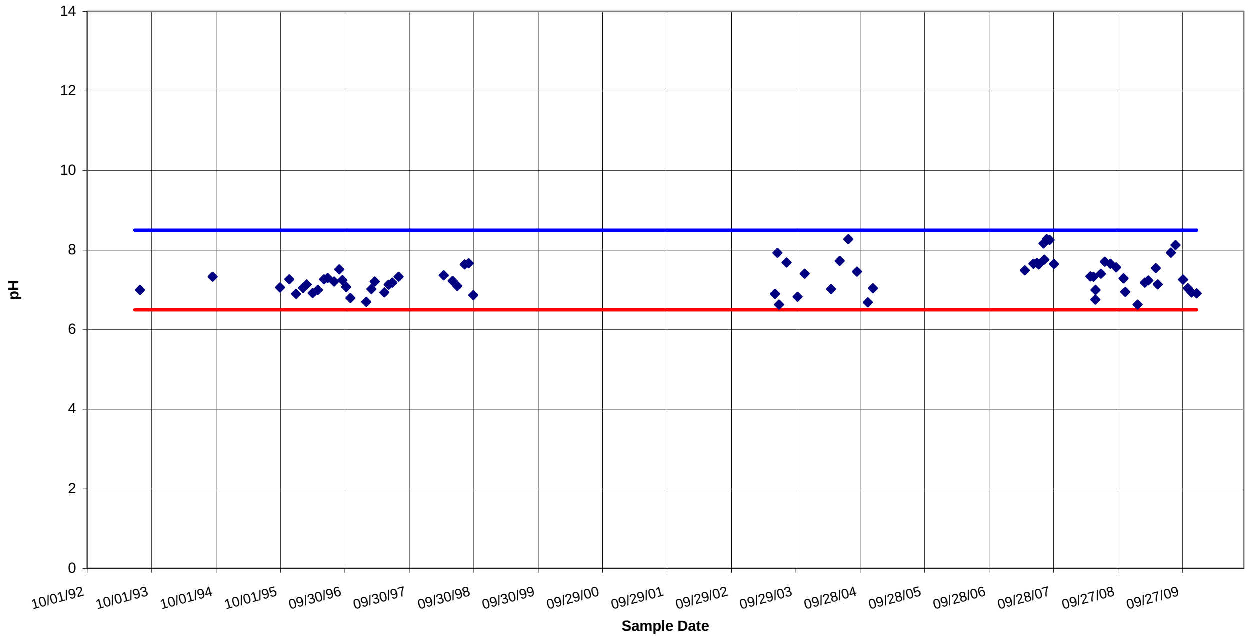

Figure 6.61 Class AA Fresh Water pH Results, Site SW009

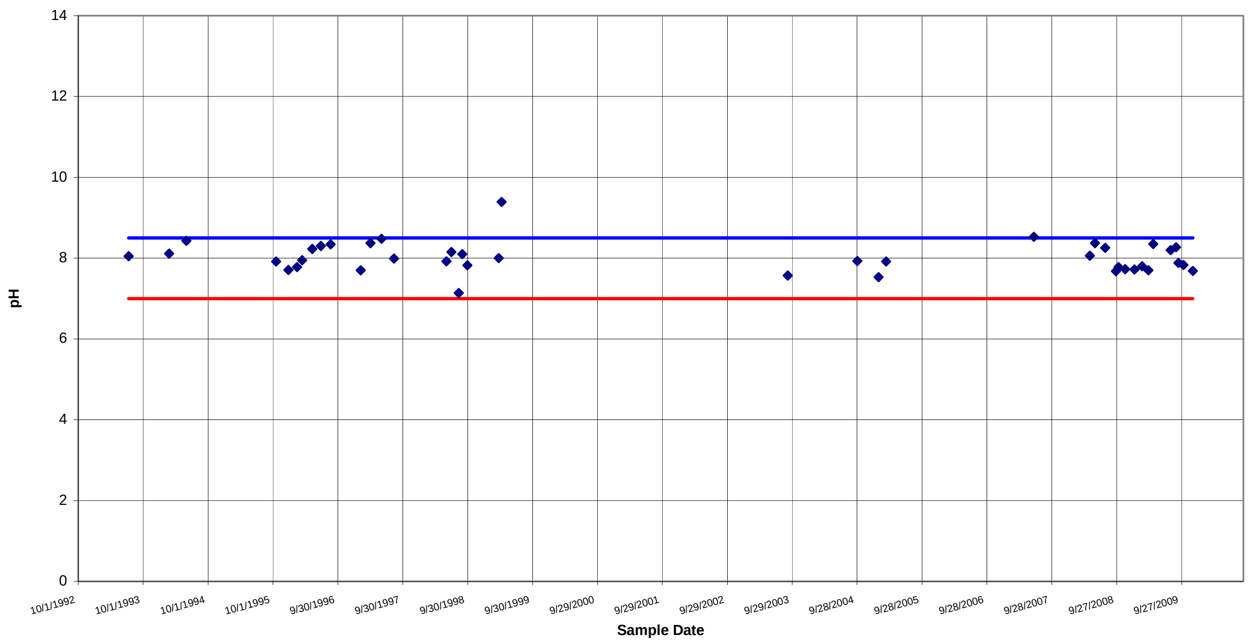

Figure 6.62 Class AA Marine Water pH Results, Site SW002

6.6.2. Class A Waters

The Class A fresh water quality standard for pH is not less than 6.5 and not more than 8.5. As shown in Figure 6.63, the water quality data collected during 2009 indicate that the standard was achieved at 6 of the 9 sample sites. Although sample sites SW024 and SW025 are shown in Figure 6.63 to have met the pH standard during 2009, these results reflect only one sample at each site. As shown in Figure 6.64, the pH standard was achieved only at Site SW037 for the period of record. Site SW037 is along a relatively dense residential area along the Portage Bay shoreline. The lowest pH values were measured at Site SW033, which drains a wooded area along the Lummi Peninsula.

The Class A marine water quality standard for pH is not less than 7.0 and not more than 8.5. As shown in Figure 6.65, the water quality data collected during 2009 indicate that this standard was achieved at all Class A marine water quality sample sites. As shown in Figure 6.66, none of the sample sites met the standard consistently over the period of record. At 3 of the 7 sites, the pH was above the maximum pH threshold and below the minimum pH threshold at least once. The highest pH value was measured at the sample site located toward the middle of Portage Bay (SW006) and the lowest pH value was measured in another part of Portage Bay just offshore of Site SW024 (SW023).

As shown in Figure 6.67, the pH sample results for the representative Class AA fresh water site that contributes to a Class A marine water site (SW018/SW118 on the Nooksack River along the Reservation boundary) have generally met the standard over the period of record but there have been several measurements both above and below the standard. As shown in Figure 6.68, the pH sample results for the representative Class A marine water site (SW030 in Bellingham Bay) have generally met the standard but there are several measurements below the 7.0 pH units threshold over the period of record. Similar to the Class AA pH results, Figure 6.67 and Figure 6.68 show the gap in the pH data record that resulted from a combination of equipment malfunctions and staff changes.

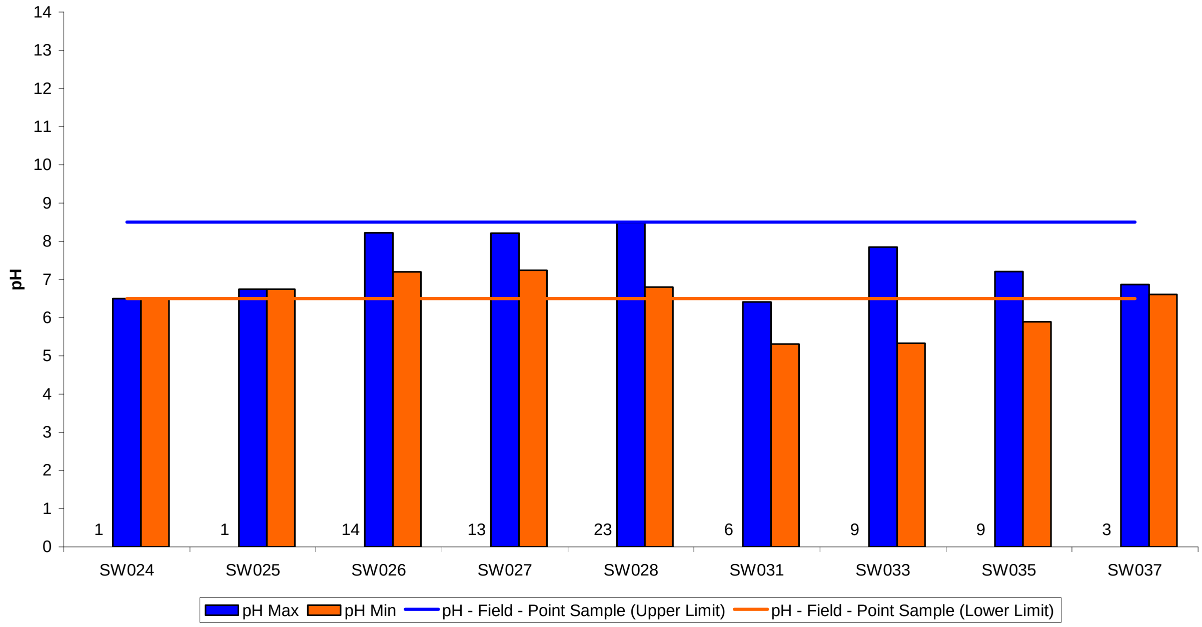

Figure 6.63 Class A Fresh Water pH Results Compared with Water Quality Standards: 2009

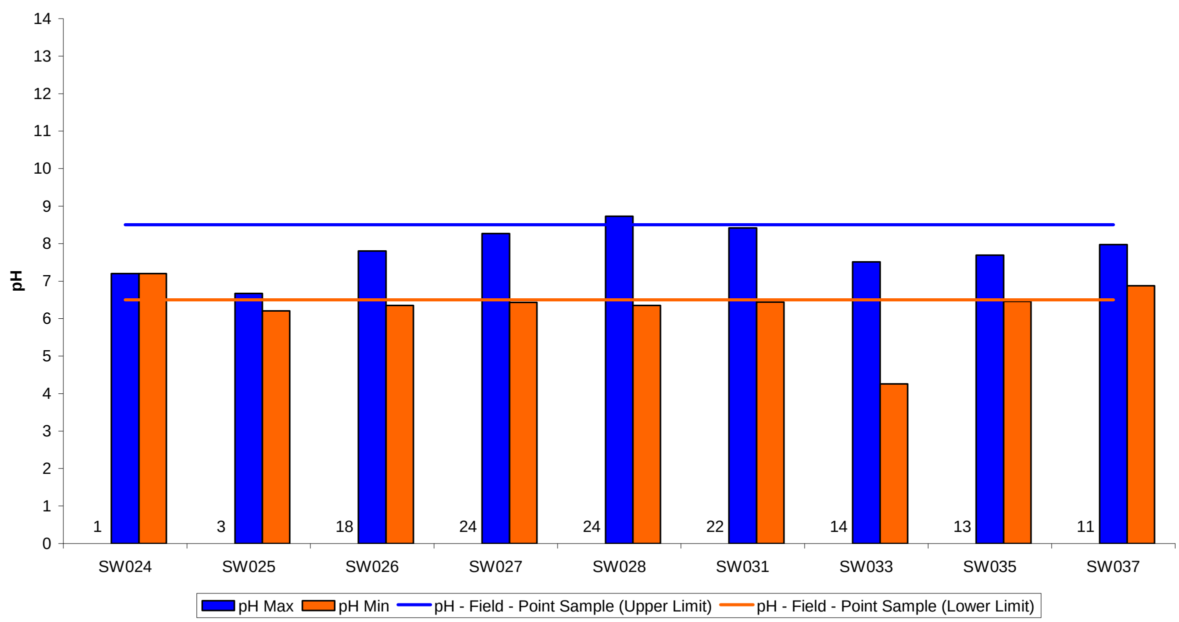

Figure 6.64 Class A Fresh Water pH Results Compared with Water Quality Standards: Period of Record through 2008

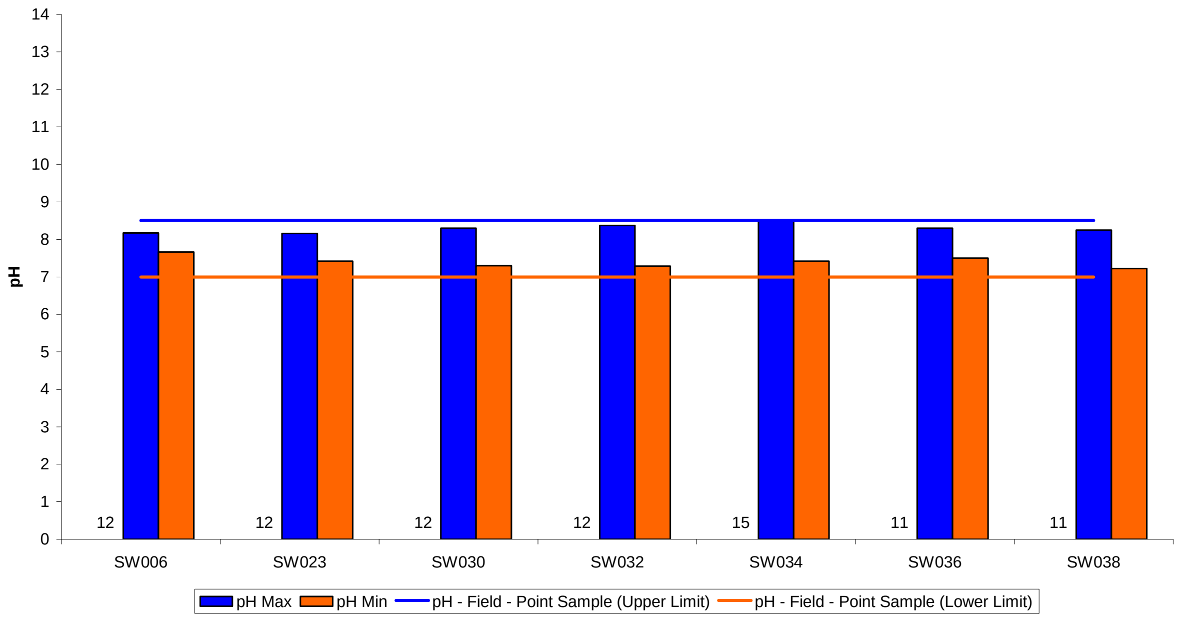

Figure 6.65 Class A Marine Water pH Results Compared with Water Quality Standards: 2009

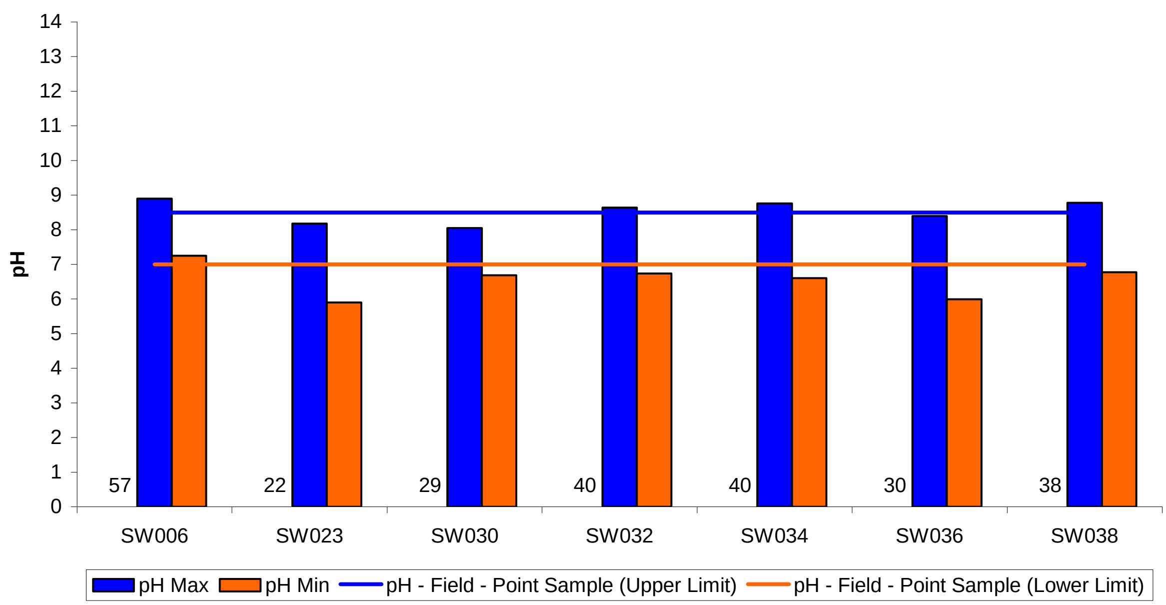

Figure 6.66 Class A Marine Water pH Results Compared with Water Quality Standards: Period of Record through 2008

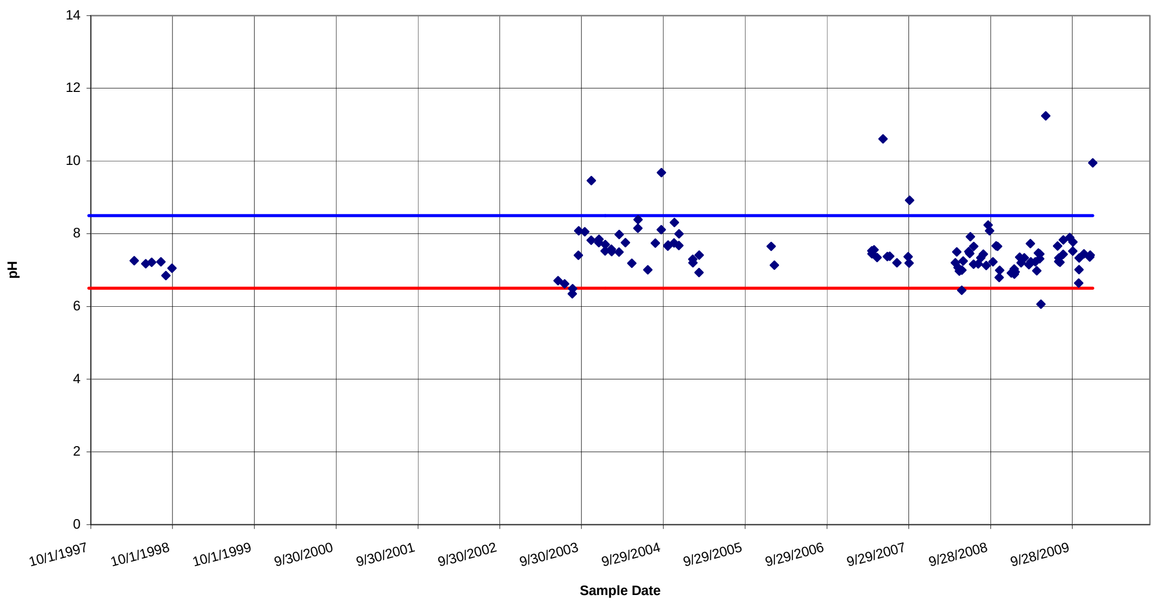

Figure 6.67 Class AA Fresh Water pH Results, Site SW018/SW118

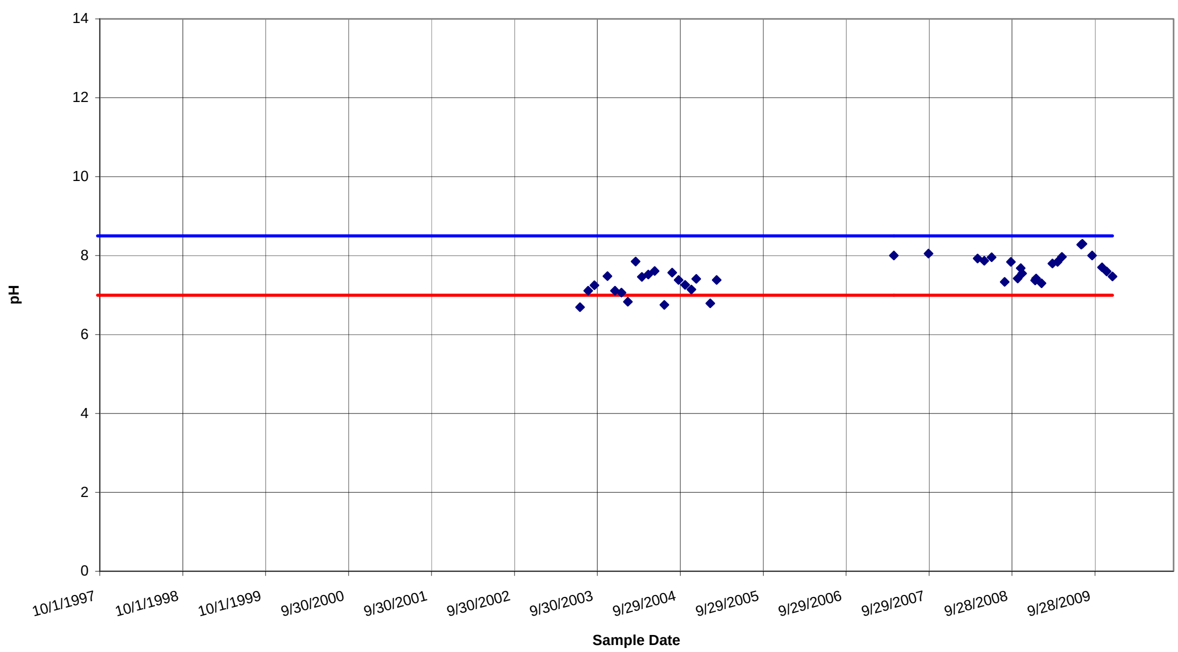

Figure 6.68 Class A Marine Water pH Results, Site SW030

6.7. Turbidity Results

The turbidity water quality standard is expressed as relative to background turbidity levels and is the same for Class AA and Class A waters. To comply with the Lummi Nation water quality standards, the turbidity level shall not exceed 5 nephelometric turbidity units (NTU) over background turbidity when the background turbidity is less than or equal to 50 NTU or the turbidity shall not exceed more than 10 percent of the background turbidity when the background turbidity is greater than 50 NTU. For regulatory purposes (e.g., a construction site) the background turbidity is measured upstream from where storm water from a site discharges to receiving waters and compliance is determined by comparison of this upstream value with the turbidity measurement collected downstream from the point or points that the storm water from the site discharges to the receiving waters.

6.7.1. Nephelometer Results

Turbidity is a measure of the degree to which light is scattered by suspended particulate material and soluble colored compounds in the water. It provides an estimate of the muddiness or cloudiness of the water due to clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms. Turbidity is commonly measured with a nephelometer and is reported in nephelometric turbidity units (NTUs) or it is measured with a Secchi disc. Equipment and staff constraints have previously limited the collection of turbidity data at the surface water quality sample stations. These obstacles were overcome in April 2008 and a nephelometer is now used regularly to determine both background levels and for regulatory compliance with the water quality standards. On the marine boat accessible run and Lummi Bay DOH support run (Table 4.1), a Secchi disc is used to measure water clarity. Secchi depth measurements have not been collected consistently during the period of record, but since 2009 Secchi depth has been measured at all sample sites during monthly marine boat runs. It is recognized that turbidity levels are highly dependent on stream flow and that since stream flow is not commonly measured at most of the sample stations, the comparability of the turbidity data between sites and sampling events is limited. However, the increased measurement of turbidity as part of the ambient water quality program will help establish the background turbidity level for compliance with the water quality standards.

As shown in Figure 6.69, 2 of the 15 Class AA fresh water sample sites were always below 50 NTU during 2008 and 2009. The average turbidity was below 50 NTU at 11 of the 15 sites. During 2008 and 2009, the highest Class AA fresh water turbidity measured was 479 NTU at Site SW007 (a Nooksack River distributary channel) and the lowest turbidity measured was 2 NTU at Site SW012 (Schell Creek). As shown in Figure 6.70, during 2008 and 2009 six of the seven Class A sample sites were always below 50 NTU. Sample sites SW031, SW033, SW035, and SW037 (storm water ditches along Lummi Shore Road) have few results due to low flow or no flow during the summer months.

Turbidity is measured using the nephlometer at marine sample sites in the Lummi River Delta and along the Lummi Peninsula/Portage Bay shoreline. As shown in Figure 6.71, the turbidity at all Class AA marine sample sites was always greater than 50 NTU at least once during 2008 and 2009. However, the average turbidity was below 50 NTU at all Class AA marine sample sites. Sample Site SW008 (Lummi River at Hillaire Road) had the highest turbidity recorded, 187 NTU. Site SW008 is downstream from Site SW009 on the Lummi River but is a Class AA marine water site (LWRD 2008). The maximum turbidity at Site SW008 (187 NTU) is lower than the maximum value at Site SW009, which with 450 NTU was the second highest turbidity value of all 25 fresh water sites. As shown in Figure 6.72, all Class A marine sample sites had turbidity values exceeding 50 NTU at least once during 2008 through 2009. Sample Site SW030 (Bellingham Bay) had the highest Class A marine water turbidity recorded, 821 NTU, and an average turbidity greater than 50 NTU. As shown in Figure 6.72, the turbidity at the sample sites decreased further along the Lummi Peninsula/Portage Bay shoreline moving away from the mouth of the Nooksack River toward Hermosa Beach. These trends suggest that the large quantity of highly turbid water flowing down the Nooksack River impacts Portage Bay sample sites.

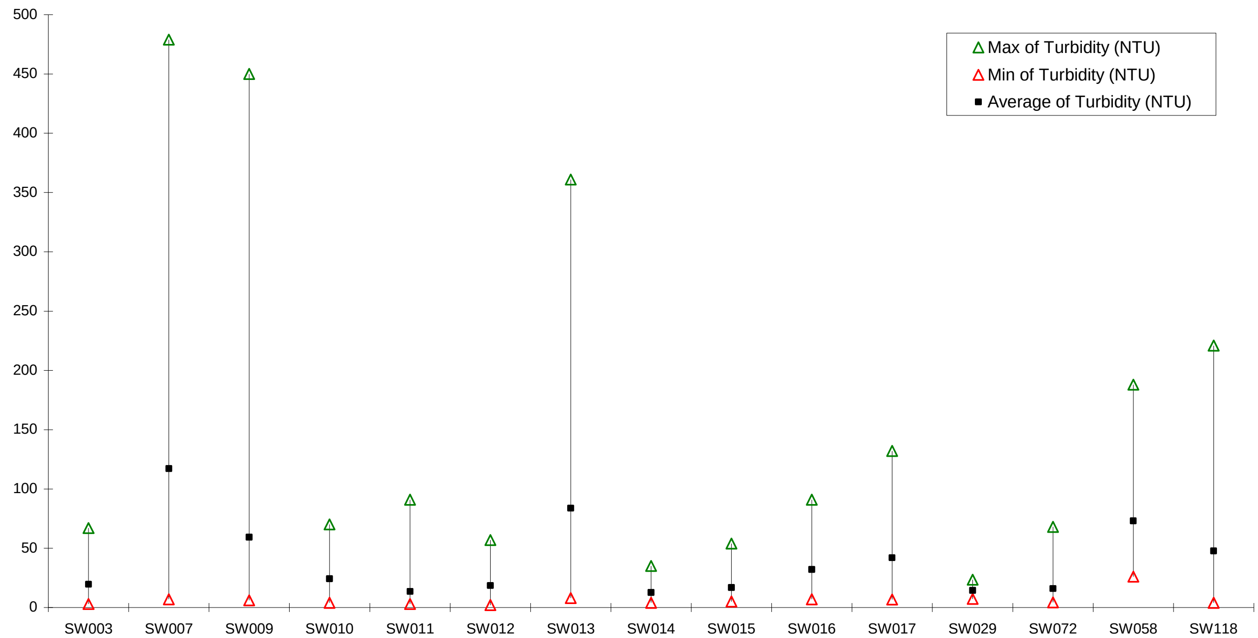

Figure 6.69 Class AA Fresh Water Turbidity Results (NTU): 2008 - 2009

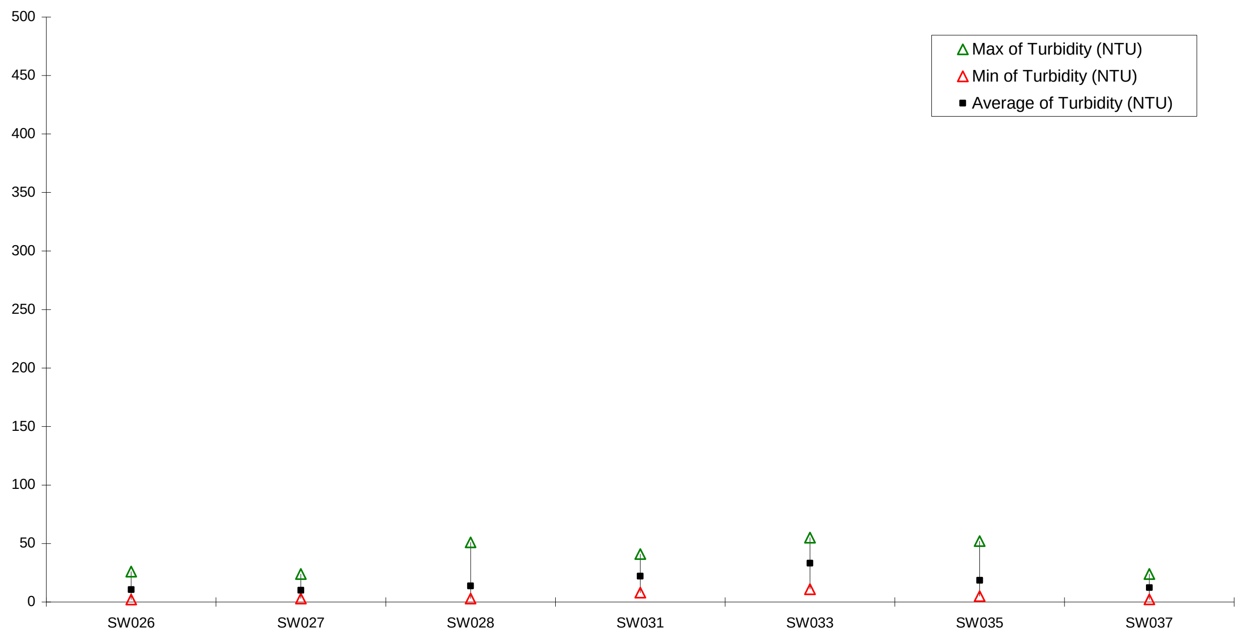

Figure 6.70 Class A Fresh Water Turbidity Results (NTU): 2008 - 2009

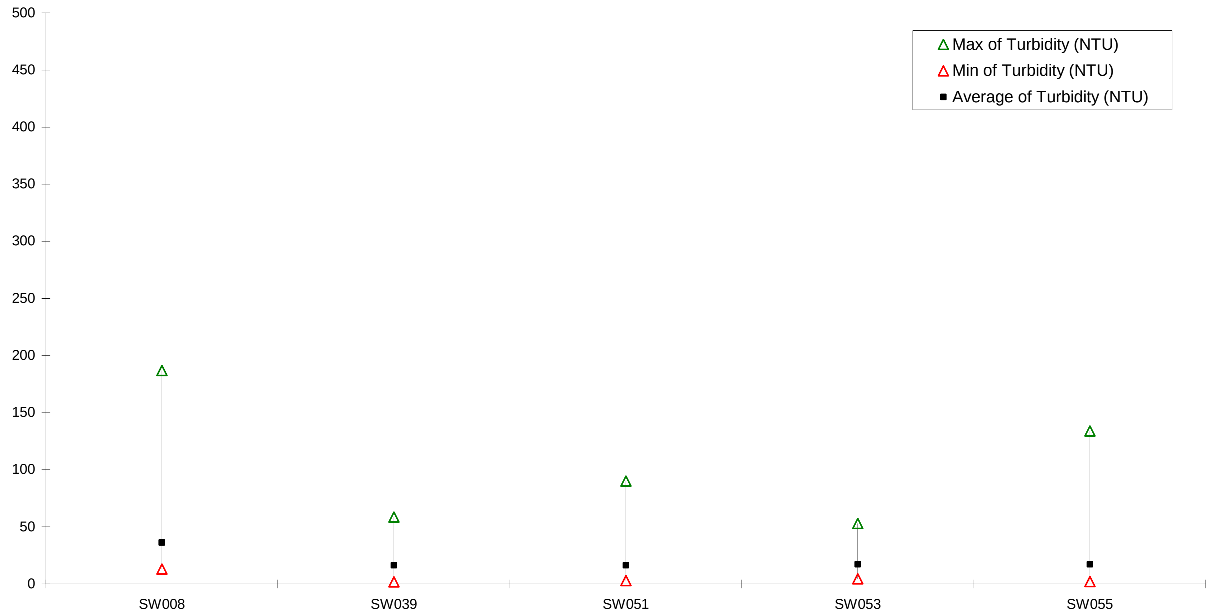

Figure 6.71 Class AA Marine Water Turbidity Results (NTU): 2008 - 2009

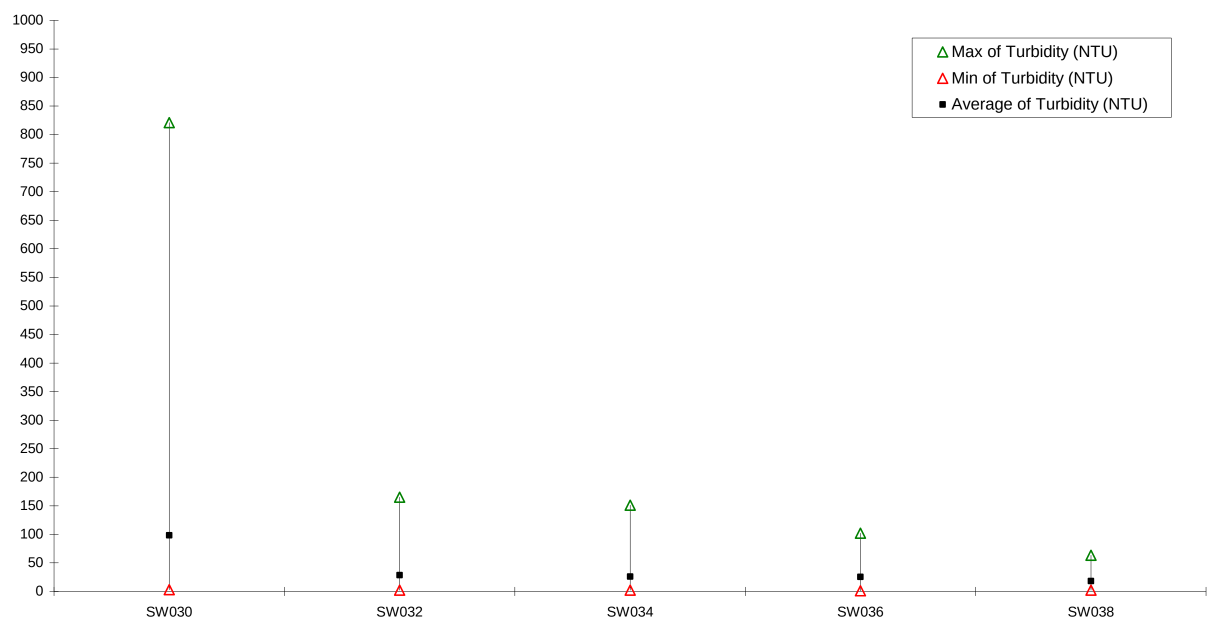

Figure 6.72 Class A Marine Water Turbidity Results (NTU): 2008 - 2009

6.7.2. Total Suspended Solid Results

Total suspended solids (TSS) are very closely associated with turbidity and is expressed in milligrams per liter (mg/l). Total suspended solids have been measured at five reference stations on a quarterly basis. The five reference stations and associated water quality classifications are the following:

- Site SW002 - Class AA Marine Water
- Site SW003 - Class AA Fresh Water
- Site SW006 - Class A Marine Water
- Site SW009 - Class AA Fresh Water
- Site SW015 - Class AA Fresh Water

During 2009, only one TSS sample was taken due to time and resource constraints. As all of the Class A fresh water sites on the Reservation are small intermittent streams, the limited availability of flow at these Class A fresh water sites makes monthly sampling for the nutrient suite (including TSS) impractical due to schedule and cost considerations.

The location sampled during 2009 was Site SW015 (Smuggler's Slough at Lummi Shore Road). On October 26, 2009, Site SW015 had a TSS level of 12 mg/L. The measurement was taken after the commencement of construction and modification of upstream sloughs for salmon habitat restoration. As shown in Figure 6.73, the quarterly TSS measurements at 3 of the 5 sample sites were below 50 mg/l during the period of record through 2009 with the lowest TSS levels measured at Site SW003 (Jordan Creek at North Red River Road) and Site SW006 (Portage Bay). As shown in Figure 6.74, the highest TSS levels were measured at Site SW009 (Lummi River at Slater Road) for the period of record through 2009. Two measurements at this station were collected on August 23, 2001 during a period when the Nooksack River was discharging to the Lummi River channel (which occurs when the flow in the Nooksack River is above approximately 9,600 cfs). A third high TSS measurement was collected November 7, 2008 following several days of significant rainfall. Although TSS measurements greater than 50 mg/l were also recorded at Site SW002, in general the TSS measurements are less than 50 mg/l. Figure 6.74 shows the TSS measurements over the period of record through 2009 at the three Class AA surface water sites in the Lummi Bay watershed. As shown in Figure 6.74, other than the two measurements collected at Site SW009 on August 23, 2001, described above, a single measurement in Lummi Bay, and one measurement in November 7, 2008, all of the TSS measurements were below 50 mg/l.

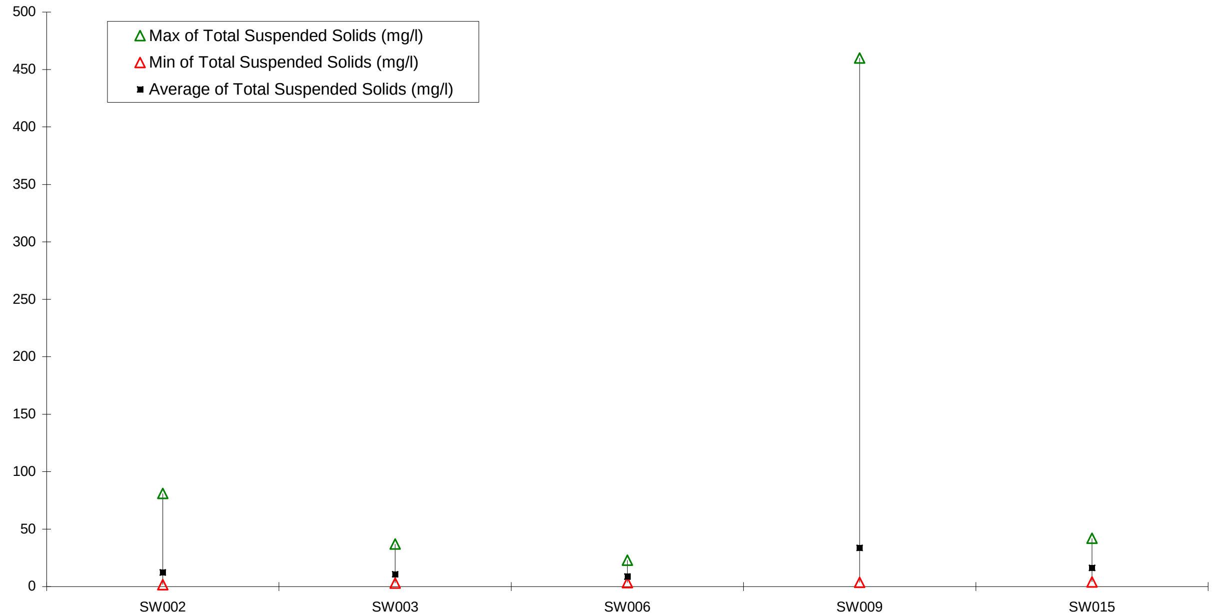

Figure 6.73 Total Suspended Solids Results: Period of Record through 2009

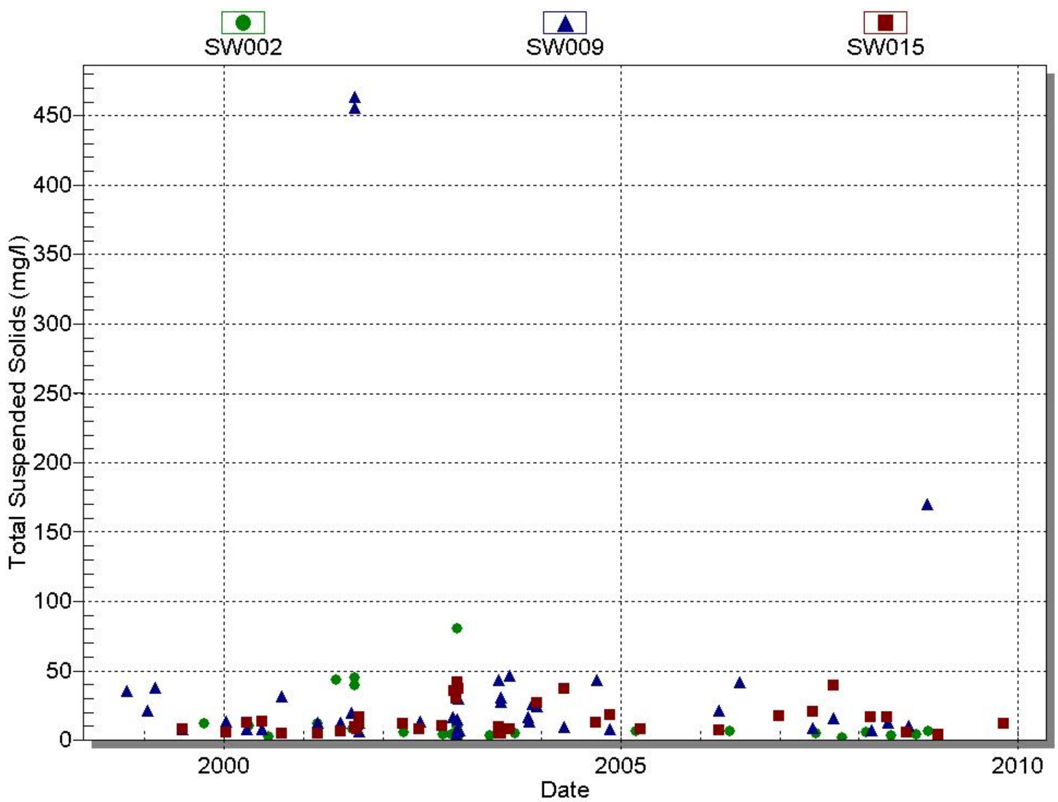

Figure 6.74 Total Suspended Solids Results at Class AA Surface Water Sites: Period of Record through 2009

6.8. Nutrients Results

A nutrient suite, including total phosphorus (milligrams per liter) and total nitrogen (milligrams per liter), is measured quarterly at the same five reference sites where TSS is measured. Similar to TSS, only one nutrient suite was collected during 2009, due to time and resource constraints. Phosphorus and nitrogen are essential nutrients for plant growth. However, elevated phosphorus and nitrogen levels can result in algae blooms, which can interfere with other aquatic life forms (Hem 1989) and can cause a number of environmental and health problems including:

- Aesthetic degradation – water with large algae blooms is murky, has bad odor, and is generally undesirable for water contact recreation such as swimming, wading, fishing, and boating.
- Aquatic habitat degradation – algae can result in low oxygen levels in the water when the algae decay, which can result in winter and summer fish kills.
- Toxin production – certain species of blue-green algae can produce toxins that can affect people and animals that swim and drink from water with severe algae blooms.
- Drinking water degradation – excessive algae in drinking water supplies can affect the taste and odor of drinking water and increase treatment costs.
- Disrupt fish harvests – excess algae can clog fishing nets.

6.8.1. Total Phosphorus Results

During 2009, one total phosphorus sample was collected at Site SW015. On October 26, 2009, Site SW015 had a total phosphorous level of 0.72 mg/L. As shown in Figure 6.75, Site SW009 had the highest total phosphorus values measured over the period of record through 2009, and the two marine water sites (SW002 and SW006) had the lowest total phosphorus values over the period of record. The two other fresh water sample sites in the floodplain (SW003 and SW015) had similar ranges and average total phosphorus levels.

Phosphorus is highly immobile and needs to be attached to a surface for transportation. Soil is frequently a point of attachment for phosphorus, and when soils are exposed, they are very susceptible to erosion and can easily be washed into streams and bays during storm events together with the adhered phosphorus. Large areas of land that has been cleared for agriculture and construction sites and are not configured with proper best management practices can contribute a significant amount of nutrient-containing sediments to nearby water bodies.

As shown in Figure 6.76, although there are a few instances with higher total phosphorus levels in the fresh water sites, particularly along the Lummi River at Slater Road (Site SW009), the total phosphorus measurements are generally below 1 mg/l. As reported in Dunne and Leopold (1978), in 1967 a committee of the American Water Works Association (AWWA) published the range of usual concentrations of phosphorus in discharges from various land uses. The usual concentration of phosphorus in rural runoff from agricultural lands is 0.05 to 1.1 mg/l and the usual concentration of phosphorus for rural runoff from non-agricultural lands is 0.04 to 0.2 mg/l. There was insufficient data for the AWWA committee to make an estimate for the usual range of phosphorus concentration where farm animal waste was the source, but the committee estimated a range of 3.5 to 9 mg/l of phosphorus for domestic waste. The concentration of total phosphorus at the fresh water sites indicates that the sources of phosphorus are from agricultural land, which is prevalent in off-Reservation watersheds.

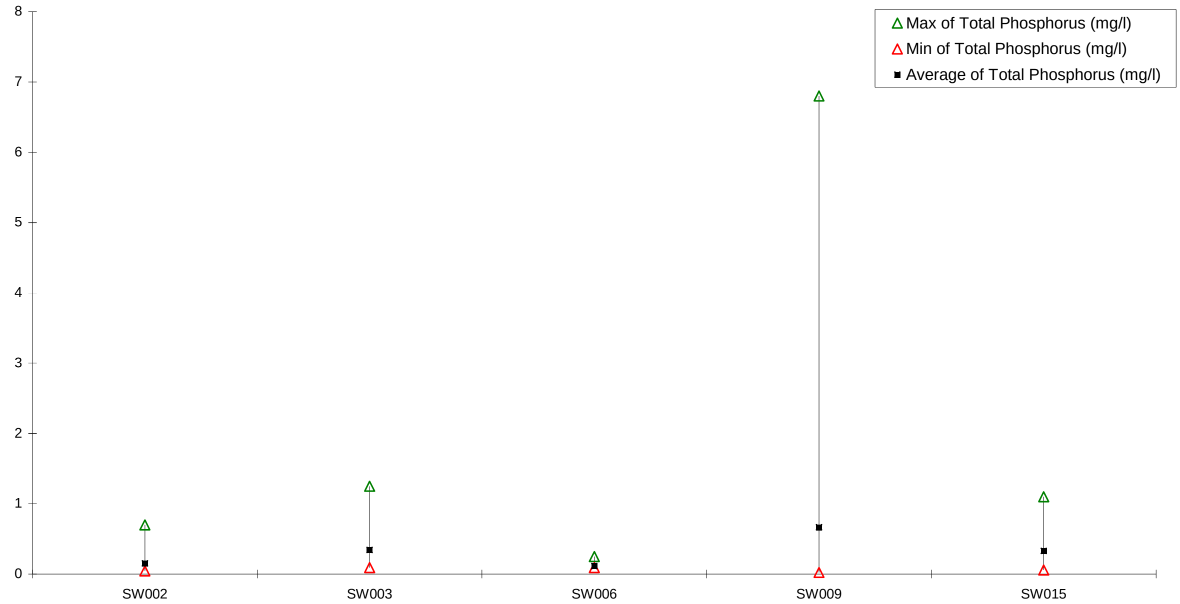

Figure 6.75 Total Phosphorus Results: Period of Record through 2009

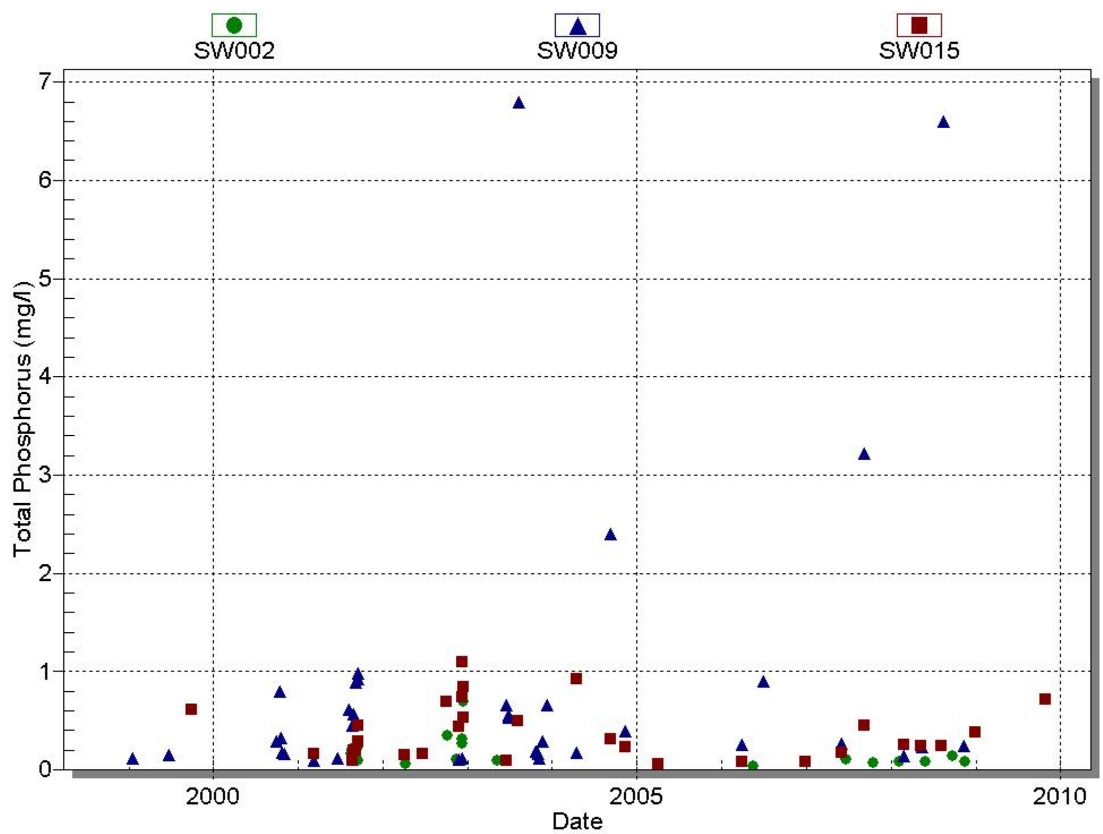

Figure 6.76 Total Phosphorus Results at Class AA Surface Water Sites: Period of Record through 2009

6.8.2. Total Nitrogen Results

Total nitrogen (milligrams per liter) is the sum of the various forms of nitrogen (nitrite, nitrate, and Total Kjeldahl Nitrogen). In the water quality samples collected on the Reservation, the form of nitrogen with the largest concentration was typically Total Kjeldahl Nitrogen (TKN), which is the sum of ammonia (NH_3) and organic nitrogen. As described above, total nitrogen was only collected at Site SW015 during 2009. The total nitrogen concentration at Site SW015 on October 26, 2009 was 1.54 mg/L. As shown in Figure 6.77, similar to TSS and total phosphorous, the highest total nitrogen values measured over the period of record through 2009 were at Site SW009 (Lummi River at Slater Road), and the lowest levels measured were at the marine water sites in Lummi Bay (SW002) and Portage Bay (SW006).

As shown in Figure 6.78, the Total Kjeldahl Nitrogen levels in the fresh water sites are all less than 10 mg/l. As reported in Dunne and Leopold (1978), in 1967 a committee of the American Water Works Association (AWWA) published the range of usual concentrations of nitrogen in discharges from various land uses. The usual concentration of nitrogen in rural runoff from agricultural lands is 1 to 70 mg/l and the usual concentration of nitrogen for rural runoff from non-agricultural lands is 0.1 to 0.5 mg/l. There was insufficient data for the AWWA committee to make an estimate for the usual range of nitrogen concentration where farm animal waste was the source, but the committee estimated a range of 18 to 20 mg/l of nitrogen for domestic waste. Based on the concentrations from the AWWA committee, the high levels of total nitrogen at Site SW009 indicate that dairy waste spills or manure applications during the wet season could be the source.

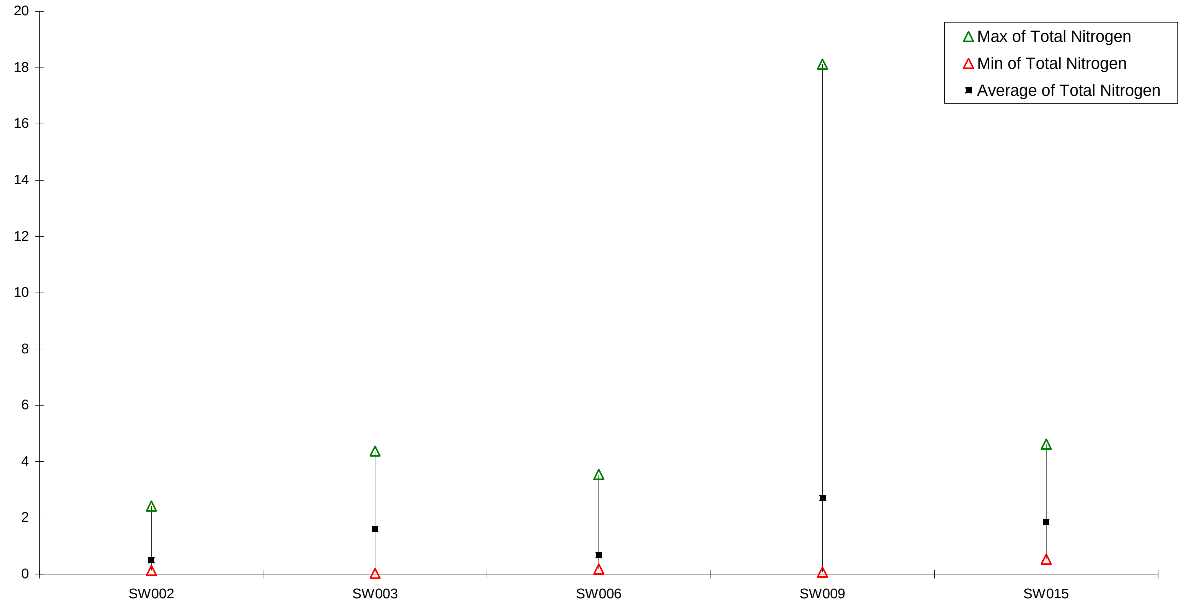

Figure 6.77 Total Nitrogen Results: Period of Record through 2009

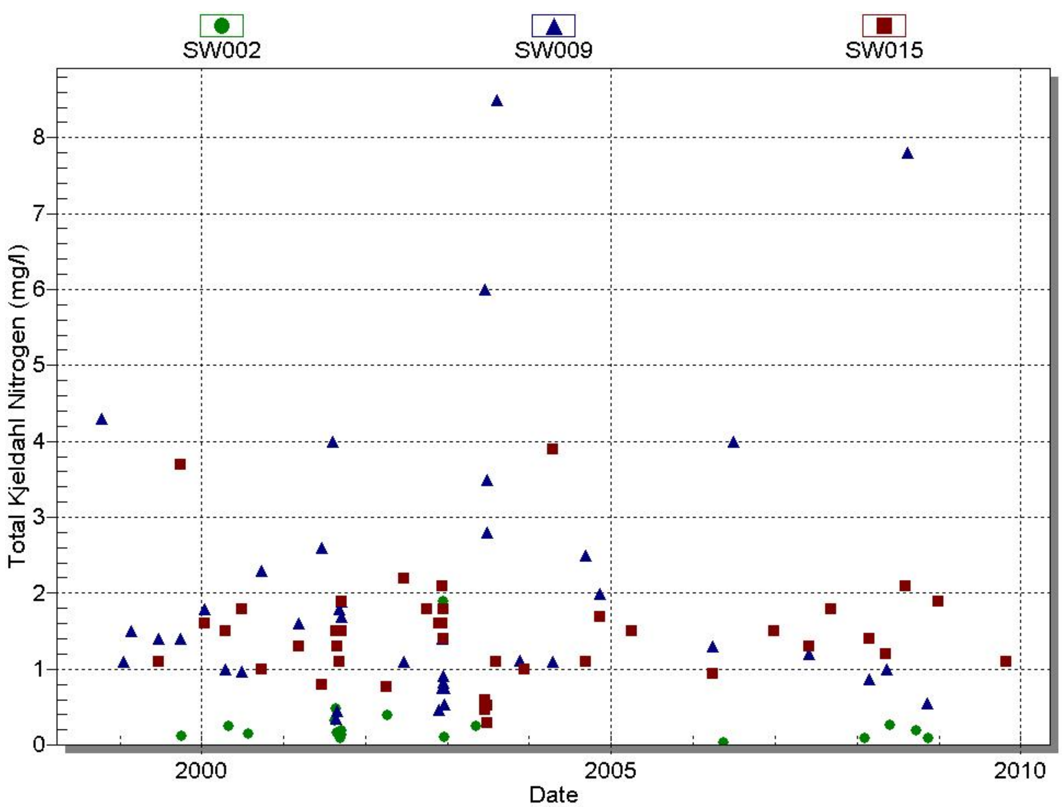

Figure 6.78 TKN Results at Class AA Surface Water Sites: Period of Record through 2009

7. DISCUSSION

More consistent and complete sampling was conducted during 2009 compared to the 2005 through 2007 period as a result of improved staff stability. Reservation water quality remains complex due to the interaction of marine waters and fresh water, variable tidal conditions during sampling, and seasonal weather patterns. During the summer, upland sites can dry out or become saline, and are often heated due to solar radiation. Once the wet season starts, flow begins at the sites that dried out, and the water column becomes less saline. At this time the waters tend to have dense populations of bacteria and low concentrations of dissolved oxygen (bacteria consume oxygen, which contribute to the lower dissolved oxygen levels). The cycle starts again at the beginning of the next dry season.

The water quality parameters at most of the sites during 2009 followed the trends of the 2003 to 2008 period: a recurrence of elevated bacteria levels, elevated temperatures, and low dissolved oxygen levels compared to the improvements in these parameters observed during 2000 and 2001. As shown in Table 7.1 and Table 7.2, the water quality at many sites during 2009 did not meet one or more of the water quality standards. None of the sample sites in the Lummi Bay Watershed achieved all of the water quality standards during 2009.

The main stem of the Nooksack River at Marine Drive (SW118) showed a decrease in bacteria levels during 2009 compared to levels observed during 2003 through 2008. Although improvements in bacteria levels were observed during 2009 in the Nooksack River, the site exceeded the 90th percentile water quality standard for a Class AA fresh water body. In addition, the sample sites in Portage Bay (SW030, SW032, SW034, SW036, and SW038) continue to not meet the Class A marine water quality standards for fecal coliform bacteria. Overall, a continuing trend observed in both the Bellingham and Lummi Bay watersheds was the introduction of fecal contamination into these bays from rivers, ditches, and streams originating off the Reservation. There are water quality and water quantity challenges in the Nooksack and Lummi River watersheds due to off-Reservation land development and agriculture. The primary data relationships used to form these conclusions were the elevated fecal coliform bacteria levels at fresh water sites, and the relatively low fecal coliform bacteria levels at marine water sites.

Dilution and deactivation from the saline waters in the bays decreased the bacteria densities from the levels found in the fresh water sample sites, but not sufficient so as to consistently avoid exceeding water quality criteria protective of shellfish harvesting. Figure 7.1 and Figure 7.2 show how the geometric mean of the fecal coliform bacteria density decreases moving downstream in the Lummi River and Jordan Creek watersheds both of which discharge to Lummi Bay. Site SW009 shown in Figure 7.1 is located in the Lummi River channel at the northern boundary of the Reservation, Site SW008 is located where the Lummi River channel flows under the Hillaire Road bridge, Site SW051 is where the Lummi River discharges to Lummi Bay, and sites DH288, DH040, and SW002 are located in Lummi Bay (see Figure 4.1). The geometric mean decreases along the Lummi River from 254 cfu/100 ml at the Reservation boundary (SW009) to 9 cfu/100 ml at the mouth of the Lummi River (SW051). Sites SW010 and SW011 shown in Figure 7.2 are located along the northern Reservation boundary and contribute to site SW003, which is located just upstream from where the channel flows under North Red River Road. Site SW053 is located just downstream from the tide gates at Lummi Bay at the mouth of Jordan Creek, and sites DH286 and DH287 are located in Lummi Bay. The geometric mean decreases along Jordan Creek from 92 cfu/100 ml and 156 cfu/100ml at the Reservation boundary (SW010 and SW011 respectively) to 29 cfu/100 ml at the mouth of Jordan Creek (SW053), and to 4 cfu/100 ml and 3 cfu/100 ml in Lummi Bay (DH286 and DH287 respectively).

Figure 7.3 and Figure 7.4 show how the 90th percentile of the fecal coliform bacteria density decreases moving downstream in the Lummi River and Jordan Creek watersheds which discharge to Lummi Bay. The 90th percentile decreases along the Lummi River from 2,400 cfu/100 ml at the Reservation boundary (SW009) to 66 cfu/100 ml at the mouth of the Lummi River (SW051). The 90th percentile decreases along the Jordan Creek from 2,400 cfu/100 ml and 1,200 cfu/100ml at the Reservation boundary (SW010 and SW011 respectively) to 210 cfu/100 ml at the mouth of Jordan Creek (SW053), to 43 cfu/100 ml and 23 cfu/100 ml in Lummi Bay (DH286 and DH287 respectively).

Figure 7.5 shows how the geometric mean of the fecal coliform bacteria density decreases moving from the Nooksack River main channel south into Portage/Bellingham Bay. The geometric mean decreases in the Nooksack River from 32 cfu/100 ml at the Reservation boundary (SW118) to 4 cfu/100 ml at the southeastern most DOH site in Portage Bay (DH49). Figure 7.6 depicts a similar decreasing trend for the 90th percentile of fecal coliform bacteria at the same sites in the Bellingham Bay watershed. The 90th percentile decreases from 134 cfu/100 ml in the Nooksack River at the Reservation boundary (SW118) to 41 cfu/100 ml at the southeastern most DOH site in Portage Bay (DH49). Site SW118 shown in Figure 7.5 and Figure 7.6 is the main stem of the Nooksack River just below the Marine Drive Bridge, and sites DH271, DH51, DH50, DH272, and DH49 are DOH sites along Hermosa Beach in Portage Bay.

Overall, when comparing fecal coliform densities in the two major watersheds on the Reservation (Lummi Bay and Portage Bay), water quality sites in the Lummi Bay watershed have a higher geometric mean and 90th percentile than sites in the Portage Bay watershed. In Figure 7.1 and Figure 7.2, which depict changes in fecal coliform bacteria geometric mean moving downstream in the Lummi Bay watershed, the y-axis (fecal coliform bacteria densities) ranges from 0 – 350 cfu/100 ml. In comparison, Figure 7.5 shows Portage Bay watershed fecal coliform geometric means ranging between 0 – 50 cfu/100 ml. Similar results are observed in the 90th percentile calculations for fecal coliform bacteria. Sample sites in the Lummi Bay watershed range between 0 – 3,000 cfu/100 ml and sample sites in the Portage Bay watershed range from 0 – 250 cfu/100 ml. The poor water quality in the Lummi Bay watershed is a major concern due to the potential for new closures of important tribal shellfish beds.

Table 7.1 Extent Lummi Bay Waters Meet Lummi Water Quality Standards and Designated Uses are Supported During 2009

	Location	Dissolved Oxygen (mg/L) Assessment	Temperature (^{o}C) Assessment	pH Assessment	Fecal Coliform Bacteria (cfu/100ml) Assessment	Enterococcus (cfu/100ml) Assessment	Full Support
LUMMI BAY WATERSHED	**Jordan Creek**						**NO**
	SW010	**X**	**X**	**X**	**X**	**X**	
	SW011	**X**	**X**	•	**X**	**X**	
	SW003	**X**	**X**	•	**X**	**X**	
	SW053	**X**	**X**	**X**	**X**	**X**	
	Lummi River						**NO**
	SW009	**X**	**X**	•	**X**	**X**	
	SW008	**X**	**X**	•	**X**	**X**	
	SW055	**X**	**X**	**X**	**X**	**X**	
	SW051	**X**	**X**	**X**	**X**	**X**	
	Smuggler's Slough						**NO**
	SW072	**X**	**X**	**X**	**X**	**X**	
	SW015	**X**	**X**	**X**	**X**	**X**	
	SW059	**X**	**X**	•	**X**	**X**	
	SW056	**X**	**X**	**X**	**X**	**X**	
	Schell Creek						**NO**
	SW012	**X**	**X**	•	**X**	**X**	
	Onion Creek						**NO**
	SW014	**X**	**X**	•	**X**	**X**	
	Seapond Creek						**NO**
	SW029	**X**	•	**X**	**X**	•	
	East Reservation Boundary						**NO**
	SW016	**X**	**X**	•	**X**	**X**	
	SW017	**X**	**X**	**X**	**X**	**X**	
	Sandy Point Channel						**NO**
	SW001	**X**	**X**	•	•	•	
	SW019	**X**	**X**	•	•	**X**	
	Lummi Bay						**NO**
	SW002	•	**X**	•	•	•	
	SW022	•	**X**	•	•	•	
	DH38	•	**X**	•	•	**N/A**	
	DH39	**X**	**X**	•	•	**N/A**	
	DH40	**X**	**X**	•	•	**N/A**	
	DH41	**X**	**X**	•	•	**N/A**	
	DH42	**X**	**X**	•	•	**N/A**	
	DH43	**X**	**X**	•	•	**N/A**	
	DH285	**X**	**X**	•	•	**N/A**	
	DH286	**X**	**X**	•	•	**N/A**	
	DH287	**X**	**X**	•	•	**N/A**	
	DH288	**X**	**X**	•	•	**N/A**	

X – Water quality parameter does not meet the Lummi Water Quality Standard
• – Water quality parameter meets the Lummi Water Quality Standard
N/A – Water quality parameter is not measured as part of the Program

Table 7.2 Extent Bellingham Bay Waters Meet Lummi Water Quality Standards and Designated Uses are Supported During 2009

	Location	Dissolved Oxygen (mg/L) Assessment	Temperature (^{o}C) Assessment	pH Assessment	Fecal Coliform Bacteria (cfu/100ml) Assessment	Enterococcus (cfu/100ml) Assessment	Full Support
BELLINGHAM BAY WATERSHED	**Nooksack River**						**NO**
	SW118	**X**	**X**	**X**	**X**	**X**	
	Kwina Slough						**NO**
	SW007	**X**	**X**	**X**	**X**	**X**	
	Lummi Shore Road Watershed						**NO**
	SW032	•	**X**	•	**X**	**X**	
	SW034	•	**X**	•	**X**	**X**	
	SW036	•	**X**	•	**X**	**X**	
	SW038	•	**X**	•	**X**	**X**	
	SW031	•	•	**X**	•	•	
	SW033	**X**	•	**X**	**X**	**X**	
	SW035	**X**	•	**X**	•	**X**	
	SW037	•	•	**X**	**X**	**X**	
	SW039	•	**X**	**X**	**X**	**X**	
	Portage Island						**NO**
	SW024	•	•	•	**X**	**X**	
	SW025	•	•	•	**X**	**X**	
	SW026	**X**	**X**	•	**X**	**X**	
	SW027	•	**X**	•	**X**	**X**	
	SW028	**X**	**X**	•	**X**	**X**	
	Portage Bay						**NO**
	SW006	•	**X**	•	•	•	
	SW023	•	**X**	•	**X**	**X**	
	SW030	•	**X**	•	**X**	**X**	
	DH49	•	•	•	•	**N/A**	
	DH50	•	•	•	•	**N/A**	
	DH51	•	•	•	•	**N/A**	
	DH52	•	•	•	**X**	**N/A**	
	DH53	•	•	•	•	**N/A**	
	DH54	•	•	•	•	**N/A**	
	DH55	•	•	•	•	**N/A**	
	DH57	•	•	•	•	**N/A**	
	DH58	•	•	•	•	**N/A**	
	DH271	•	•	•	•	**N/A**	
	DH272	•	•	•	•	**N/A**	

X – Water quality parameter does not meet the Lummi Water Quality Standard
• – Water quality parameter meets the Lummi Water Quality Standard
N/A – Water quality parameter is not measured as part of the Program

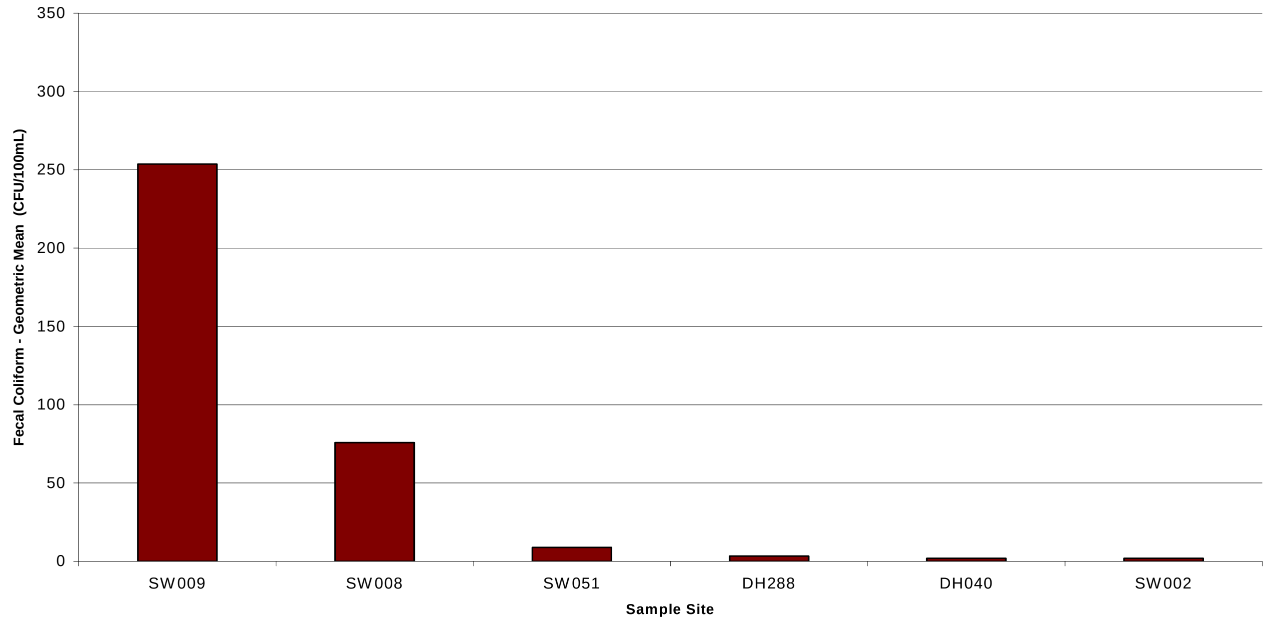

Figure 7.1 Changes in the Geometric Mean of Fecal Coliform Bacteria Sample Results in the Lummi River and Lummi Bay: Period of Record through 2009

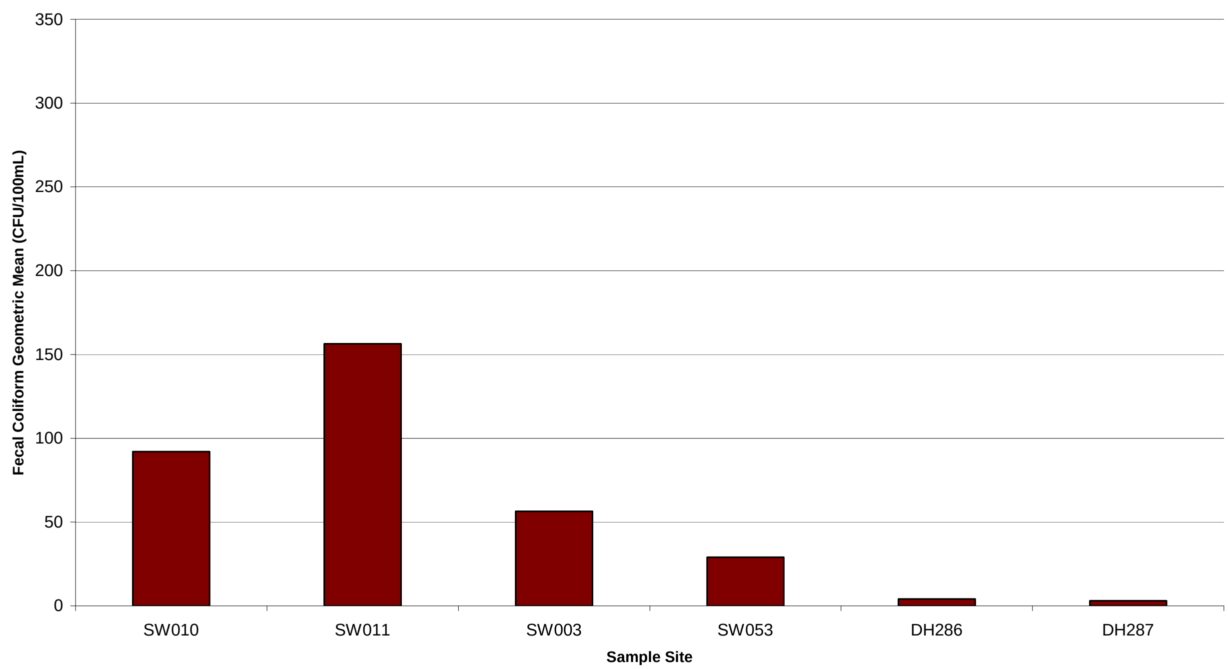

Figure 7.2 Changes in the Geometric Mean of Fecal Coliform Bacteria Sample Results in the Jordan Creek/Lummi Bay Watershed: Period of Record through 2009

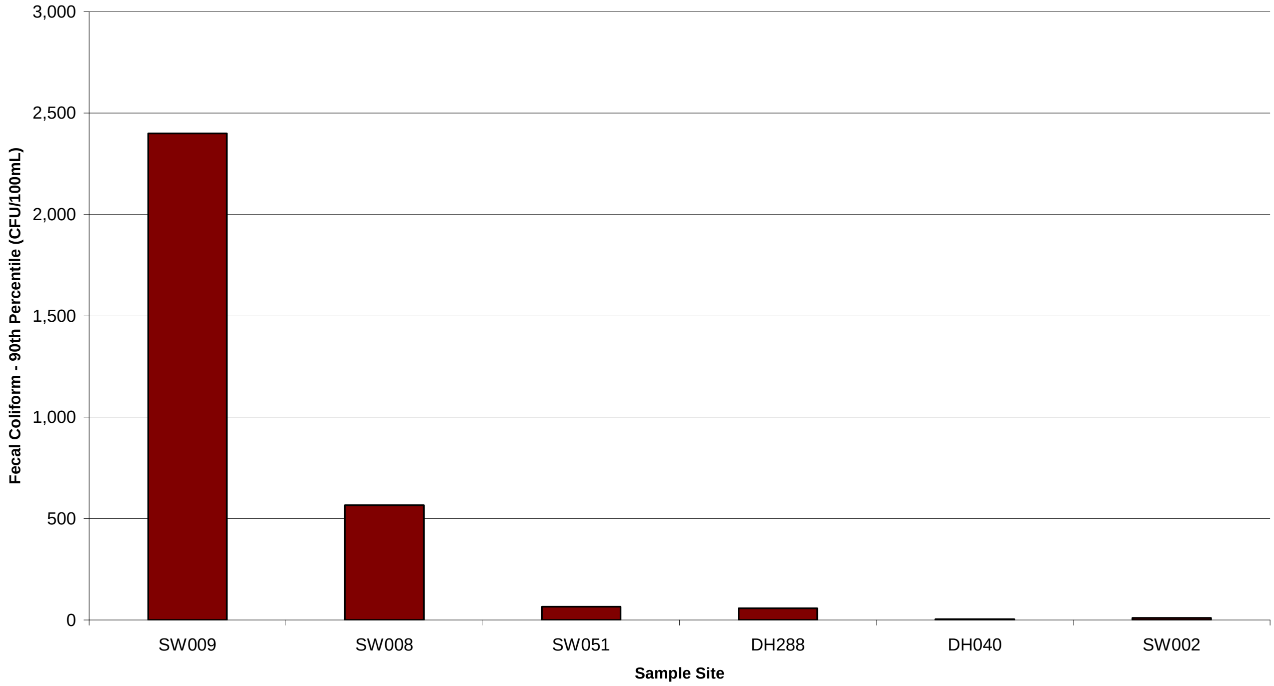

Figure 7.3 Changes in the 90th Percentile of Fecal Coliform Bacteria Sample Results in the Lummi River and Lummi Bay: Period of Record through 2009

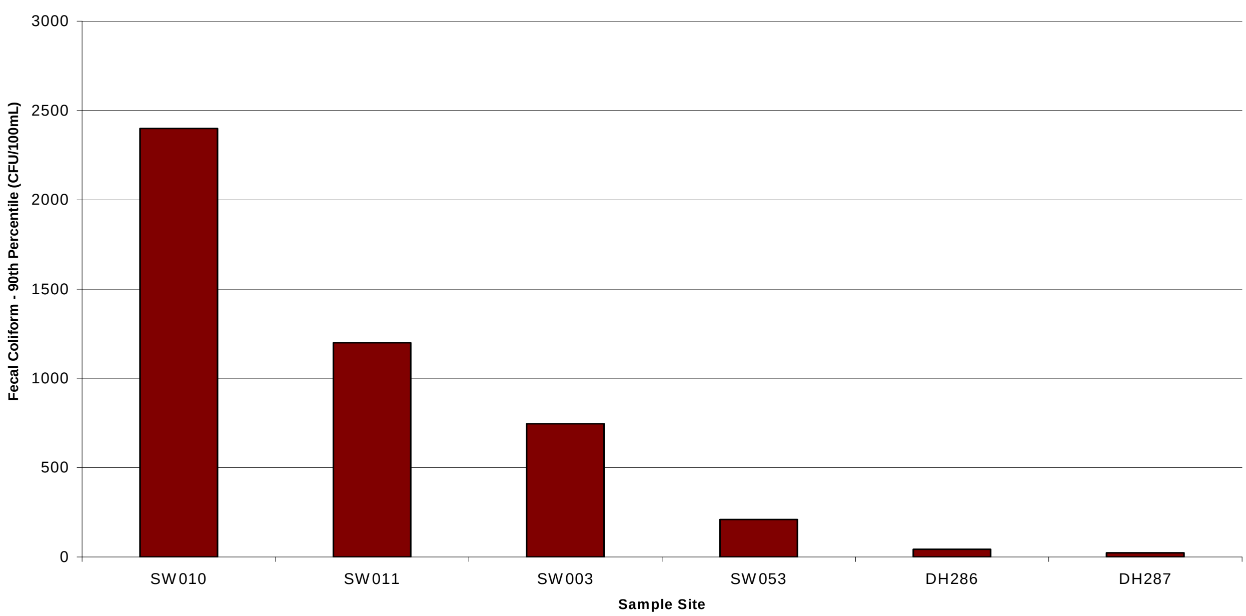

Figure 7.4 Changes in the 90th Percentile of Fecal Coliform Bacteria Sample Results in the Jordan Creek/Lummi Bay Watershed: Period of Record through 2009

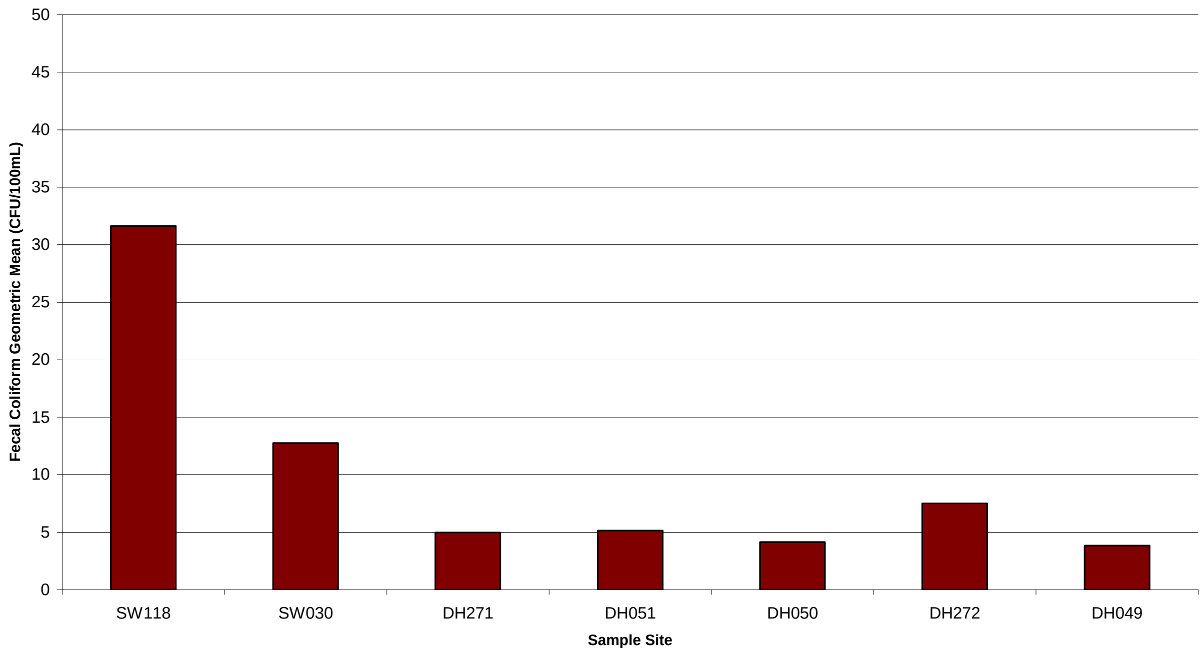

Figure 7.5 Changes in the Geometric Mean of Fecal Coliform Bacteria Sample Results in the Nooksack River/Bellingham Watershed: Period of Record through 2009

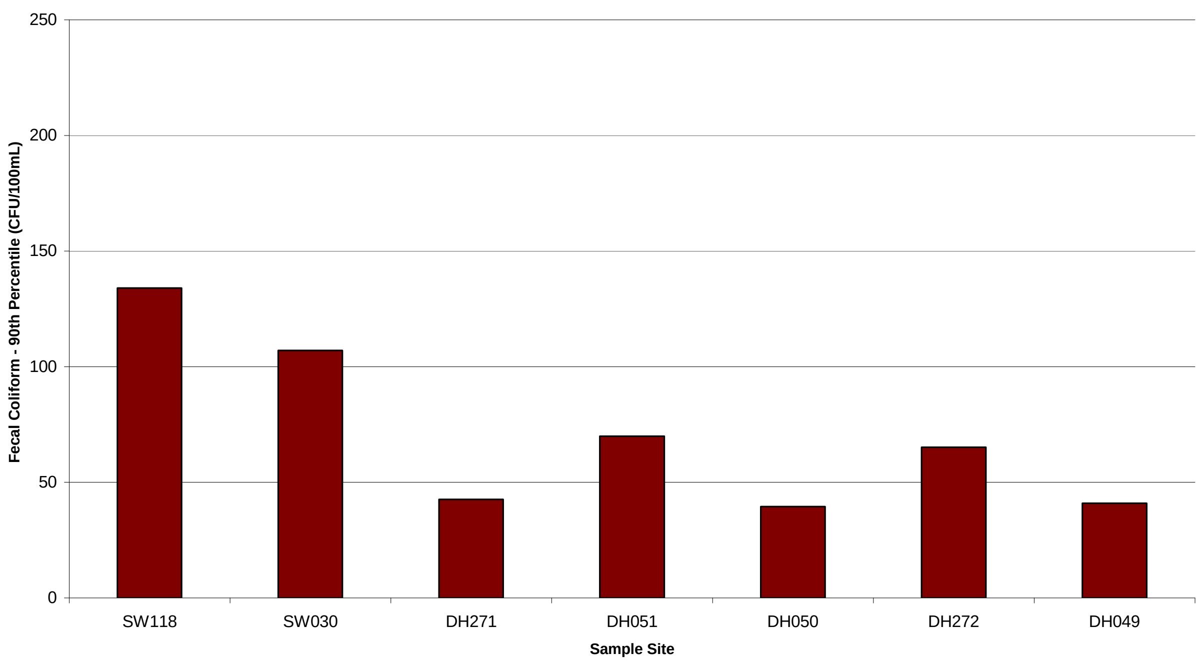

Figure 7.6 Changes in the 90^{th} Percentile of Fecal Coliform Bacteria Sample Results in the Nooksack River/Bellingham Bay Watershed: Period of Record through 2009

7.1. Causes and Sources of Lummi Waters Not Supporting Designated Uses

None of the waters in the Lummi Bay watershed and the Portage Bay watershed support their designated uses because of increased fecal coliform densities, increased temperatures, low dissolved oxygen levels, and/or pH levels (Table 7.1 and Table 7.2). In the Lummi Bay watershed, temperature, dissolved oxygen, and fecal coliform were the most common reason that designated uses are not supported. The primary source of these impairments in the Lummi Bay watershed is off-Reservation agricultural practices. In the Portage Bay watershed, fecal coliform bacteria and enterococcous were the most common causes of waters not supporting their designated use. Again, off-Reservation agricultural land uses in is the major source of high fecal coliform densities, particularly the Nooksack River watershed, which drains the majority of the agricultural lands in lower Whatcom County.

Fecal coliform bacteria are of particular importance because they are the indicator organism used in the National Shellfish Sanitation Program (NSSP) to classify shellfish beds as suitable for commercial harvest. Both the Lummi and Nooksack River watersheds contain land uses that contribute fecal coliform bacteria to surface waters. As shown in Figure 7.1 through Figure 7.4, the highest fecal coliform bacteria levels are measured along the Reservation boundary, indicating an off-Reservation source. Approximately 220 acres of tribal shellfish beds in Portage Bay were closed from November 1996 to May 2006 due to bacterial contamination attributed to poor dairy nutrient management practices in the Nooksack River (DOH 1997, Ecology 2000).

The decrease in fecal coliform bacteria densities during 2000 and 2001 in both the Nooksack River and Portage Bay was a positive indication that fecal coliform bacteria pollution prevention efforts were succeeding in the Nooksack River watershed. However, fecal coliform bacteria levels rose again in these water bodies during the 2003 to 2008 period. During 2008 and 2009, the main stem of the Nooksack River (SW118) showed a decrease in fecal coliform bacteria levels. Along the Lummi Peninsula near shore areas of Portage Bay, storm water during the onset of the wet season typically contains elevated fecal coliform bacteria levels, but flows are very low. By the time the flows increase, fecal coliform bacteria levels are substantially reduced. Intensive shoreline sampling over the 1998 through 2001 period demonstrated that local sources of fecal coliform bacteria are not a significant source of fecal contamination to Portage Bay (LWRD 1999, LWRD 2006c, LWRD 2006d). Small fresh water streams on Portage Island contain elevated fecal coliform bacteria levels, but as described above, flows are very low and do not appear to be a significant source of fecal contamination to Portage Bay. A herd of cattle present on the uninhabited Portage Island is thought to be the main source of high fecal coliform bacteria concentrations in the fresh water streams. Removal of the cattle is currently being conducted and will be completed by Spring 2010, which should reduce the fecal coliform bacteria entering Portage Bay from Portage Island.

Land use practices in the Lummi River watershed are likely the primary cause of the elevated bacteria levels, elevated temperatures, and depressed dissolved oxygen values in the surface waters along the Reservation boundary. Fecal coliform bacteria levels well above the Lummi

Nation Surface Water Quality Standards were common along the Reservation boundary sample sites in the early and mid-1990s, and had been decreasing during 2001 and 2002. However, during the 2003 through 2009 period, bacteria levels at many sites along the boundary increased again.

Just as the surface water network influences the marine waters in the bays, the marine waters influence the surface waters with upstream flows during high tides. This is especially notable in the Lummi Bay watershed where saline waters reached to the northern Reservation boundary.

As shown in Table 7.1 and Table 7.2, none of the water bodies sampled on the Reservation met water temperature water quality standards, except Seaponds Creek (SW029), which drains a forested, relatively undeveloped portion of the Reservation. Many sites exceed water temperature criteria during the summer months. Some of these exceedences are caused by naturally occurring conditions, such as Site SW002 in Lummi Bay, where the tide flat is exposed to full sunlight in the summer. However, at other sites these exceedences are likely due to human-caused factors such as the removal of riparian shade and/or drainage alterations that decrease the amount of ground water available to moderate surface water temperatures in the summer. The extent to which anthropogenic influences have contributed to elevated water temperatures at the various sample sites has not been established.

Dissolved oxygen levels also vary considerably throughout the year, and not always inversely to temperature. As shown in Table 7.1 and Table 7.2, the majority of water bodies exceed dissolved oxygen (mg/L) water quality standards except Portage Bay. It is noted that dissolved oxygen is not typically measured at Portage Bay DOH sites, but during 2009 two samples were collected. At some sites, the deviation of dissolved oxygen and temperature from their equilibrium appears to be due to elevated primary production of oxygen by algae that increases the dissolved oxygen levels concurrent with elevated temperatures. The dissolved oxygen values could range from low to high to low again over a 24-hour period. To explore this phenomenon further, water quality should be sampled several times a day over the course of several days at representative sites.

Other causes of high dissolved oxygen levels concurring with elevated water temperatures may be wave entrainment of air or the water heating more rapidly than the rate at which dissolved oxygen maintains equilibrium concentrations in water. In places such as Lummi Bay, air entrainment, primary production, and rapid heating are likely occurring and contributing to elevated dissolved oxygen values. In many places on the Reservation, dissolved oxygen values fall below applicable water quality criteria. Similar to temperature, there are places where extremely low dissolved oxygen values could be due to naturally occurring conditions (e.g., an area without shade where the streambed is in the photic zone and flows are generally low to stagnant). At sites where human created or induced changes occurred (e.g., clearing of vegetation, drainage of ground water, increased nutrient loading), the extremes of dissolved oxygen variation have likely been increased due to the human activity setting the stage for increased primary production. Similarly, high bacteria densities, often created by anthropogenic activities, can cause drops in dissolved oxygen concentrations as the bacteria consume oxygen while metabolizing. The extent to which anthropogenic influences have contributed to depressed dissolved oxygen levels at the various sample sites has not been estimated.

8. SUMMARY AND CONCLUSIONS

The goals of the Lummi Nation Surface Water Quality Monitoring Program are to document ambient water quality and water quality trends on the Lummi Indian Reservation (Reservation), evaluate regulatory compliance of waters flowing onto Reservation including compliance with Lummi Nation Surface Water Quality Standards (LWRD 2008), and support the development and implementation of water quality regulatory programs on the Reservation.

This report presents the surface water quality data collected during calendar year 2009, compares the 2009 results to data from 1993 to 2008, presents interpretations of these data with respect to the Program goals; and provides the U.S. Environmental Protection Agency (EPA) documentation required pursuant to the *Final Guidance of Awards of Grants to Indian Tribes under Section 106 of the Clean Water Act* (EPA 2006).

Water quality on the Reservation is complex for a number of reasons including the Reservation location in the estuaries of the Lummi River and the Nooksack River where marine and fresh waters interact, the approximately 38 miles of marine shoreline and 7,000 acres of tidelands, and the weather patterns that influence the water quality at the sampling sites.

The water quality parameters measured during calendar year 2009 were largely similar to the measured water quality parameters during previous years with a few exceptions. The water quality parameters at the monitoring sites during 2009 generally followed the trends of the time period 2003 to 2008. That is, generally higher bacteria levels, higher temperatures, and lower dissolved oxygen levels compared to the improvements in these parameters observed during 2000 and 2001. However, fecal coliform bacteria levels in the main stem of the Nooksack River at the Reservation border (SW118) have improved during 2009 compared to the trends of 2003 through 2007. During 2009, fecal coliform bacteria levels at Site SW118 were lower than the Total Maximum Daily Load (TMDL) target of a geometric mean of 39 coliform forming units/100 ml established for the lower Nooksack River (Ecology 2000 and 2002) but still exceeded the water quality standards for Class AA fresh water bodies because the 90th percentile standard was exceeded. The water quality parameters generally degrade in the sites further inland, and gradually improve downstream towards the marine waters on the Reservation.

The marine waters of Lummi Bay and the Sandy Point Marina continue to maintain relatively good quality, while the surface waters within the Lummi River watershed continue to have the poorest water quality of the sites sampled on the Reservation. Sampling of the Nooksack River indicated variable water quality with elevated fecal coliform bacteria readings during 2009 that are a cause of concern even though improvements were observed compared to the 2003 through 2007 period. The pattern over the past few years of decreasing water quality in the Nooksack River and Portage Bay and continuing poor water quality in the Lummi River and tributaries to Lummi Bay, particularly with respect to increased fecal coliform bacteria contamination, is a major concern due to the potential for new closures of important tribal shellfish beds. The members of the Lummi Nation use these shellfish beds for ceremonial, subsistence, and commercial purposes.

9. LIST OF REFERENCES

Cline, D.R. 1974. *A Ground Water Investigation of the Lummi Indian Reservation Area, Washington*. Tacoma, U.S. Geological Survey, Open-File Report.

Dunne, T. and L. B. Leopold. 1978. *Water In Environmental Planning*. W. H. Freeman and Company, New York. pp 758-759.

Deardorff, L. 1992. *A Brief History of the Nooksack River's Delta Distributaries*. Lummi Nation Fisheries Department.

Hem, J. 1989. *Study and Interpretation of the Chemical Characteristics of Natural Water*. USGS Water Supply Paper 2254.

Harper, K. 1999. *Lummi Nation Wetland Inventory Technical Report*. Sheldon and Associates, Inc. Seattle, Washington. Prepared for Lummi Indian Business Council, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 1997. *Lummi Nation Wellhead Protection Program --Phase I*. Prepared for Lummi Indian Business Council, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 1998. *Lummi Reservation Storm Water Management Program Technical Background Document*. Prepared for Lummi Indian Business Council, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 2000. *Lummi Indian Reservation Wetland Management Program Technical Background Document*. Prepared for Lummi Indian Business Council, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 2001. *Nonpoint Source Assessment Report.* Prepared for Lummi Indian Business Council, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 2002. *Nonpoint Source Management Plan*. Prepared for Lummi Indian Business Council, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 2006a. *Lummi Nation Water Quality Monitoring Program, Quality Assurance/Quality Control Plan. Version 3.0.* Prepared for Lummi Indian Business Council, Bellingham, Washington.

Lummi Water Resources Division (LWRD). 2006b. *Lummi Nation Water Quality Monitoring Program Database Documentation*.

Lummi Water Resources Division (LWRD). 2006c. *Preliminary Characterization of Fecal Coliform Contributions to Portage Bay from the Hermosa Beach Area 1999-2000.*

Lummi Water Resources Division (LWRD). 2006d. *Preliminary Characterization of Fecal Coliform Contributions to Portage Bay from the Hermosa Beach Area 2000-2001*.

Lummi Water Resources Division (LWRD). 2008. *Water Quality Standards for Surface Waters of the Lummi Indian Reservation.*

Lummi Water Resources Division (LWRD). 2009. *Wetland Inventory Update Year 5 Synthesis Report 2008*.

U.S. Environmental Protection Agency (EPA). 2006. *Final Guidance of Awards of Grants to Indian Tribes under Section 106 of the Clean Water Act*.

Washington State Department of Ecology (Ecology). 2000. *Nooksack River Watershed Bacteria Total Maximum Daily Load*. Pub No. 00-10-036 June.

Washington Department of Ecology (Ecology). 2002. *Nooksack River Watershed Bacteria Total Maximum Daily Load, Detailed Implementation Plan.* Publication No. 01-10-060.

Washington State Department of Health (DOH). 1997. *Sanitary Survey of Portage Bay*. Office of Shellfish Programs.

APPENDIX A: WATER QUALITY MONITORING DATA FOR 2009

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
1/19/2009	DH038	3							1.7	5			
3/4/2009	DH038	7							4.5	6			
5/27/2009	DH038	11							1.8	4			
7/23/2009	DH038	13								3			
9/23/2009	DH038	24							1.7	7			
10/8/2009	DH038	15							1.7				
11/4/2009	DH038	9							4.5	9			
1/19/2009	DH039	3							1.7	4			
3/4/2009	DH039	6							1.7	7			
5/27/2009	DH039	11							1.7	6			
7/23/2009	DH039	16								2			
9/23/2009	DH039	24							1.7	6			
10/8/2009	DH039	14							1.7	6			
11/4/2009	DH039	8.5							1.7	2			
1/19/2009	DH040	3							1.7	4			
3/4/2009	DH040	6							1.7	8			
5/27/2009	DH040	11							1.7	3			
7/23/2009	DH040	14								9			
9/23/2009	DH040	22							1.7	6			
10/8/2009	DH040	13							1.7	6			
11/4/2009	DH040	9							4.5	3			
1/19/2009	DH041	3							4.5	4			
3/4/2009	DH041	7							1.7	4			
5/27/2009	DH041	11							1.7	6			
7/23/2009	DH041	15								2			
9/23/2009	DH041	25							1.7	6			
10/8/2009	DH041	15							1.7	6			
11/4/2009	DH041	10							4.5	3			
1/19/2009	DH042	3							33	4			
3/4/2009	DH042	8								4			
5/27/2009	DH042	12							1.7	5			
7/23/2009	DH042	15								9			
9/23/2009	DH042	24							1.7	6			
10/8/2009	DH042	17							1.7	6			
11/4/2009	DH042	11							11	7			
1/19/2009	DH043	3							46	7			
3/4/2009	DH043	8							1.7	6			
5/27/2009	DH043	13							1.7	5			
7/23/2009	DH043	19								3			
9/23/2009	DH043	21							1.7	6			
10/8/2009	DH043	15							1.7	6			
11/4/2009	DH043	12							2	7			
1/19/2009	DH044								1.7				
3/4/2009	DH044	10							1.7	2			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
5/27/2009	DH044	19							79	1			
7/23/2009	DH044	21								1			
9/23/2009	DH044	18.5							1.7	1			
10/8/2009	DH044	13							1.7	4			
11/4/2009	DH044	11.5							1.7	6			
1/19/2009	DH045								1.7				
3/4/2009	DH045	10							1.7				
5/27/2009	DH045	16							1.7	8			
7/23/2009	DH045	21								1			
9/23/2009	DH045	19							1.7	1			
10/8/2009	DH045	16.5							2	4			
11/4/2009	DH045	12							1.7	6			
1/14/2009	DH048	5								7			
1/19/2009	DH048								2	9			
2/5/2009	DH048								1.7				
5/6/2009	DH048								1.7				
7/30/2009	DH048								1.7				
9/16/2009	DH048								1.7				
1/14/2009	DH049												
1/19/2009	DH049	4							1.7	8			
2/5/2009	DH049								1.7				
3/25/2009	DH049								1.7				
5/6/2009	DH049								49				
7/30/2009	DH049								4.5				
9/16/2009	DH049								1.7				
1/14/2009	DH050	6											
1/19/2009	DH050	4							2	9			
2/5/2009	DH050								1.7				
3/25/2009	DH050								1.7				
5/6/2009	DH050								46				
7/30/2009	DH050								1.7				
9/16/2009	DH050								33				
1/14/2009	DH051	6								8			
1/19/2009	DH051	4							1.7	2			
2/5/2009	DH051								2				
3/25/2009	DH051								1.7				
5/6/2009	DH051								70				
7/30/2009	DH051								2				
9/16/2009	DH051								13				
1/14/2009	DH052												
1/19/2009	DH052	4							1.7	5			
2/5/2009	DH052								2				
3/25/2009	DH052								1.7				
5/6/2009	DH052								79				

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
7/30/2009	DH052								2				
9/16/2009	DH052								13				
1/14/2009	DH053	4								8			
1/19/2009	DH053	4							1.7	2			
2/5/2009	DH053								1.7				
3/25/2009	DH053								1.7				
5/6/2009	DH053								23				
7/30/2009	DH053								2				
9/16/2009	DH053								6.8				
1/14/2009	DH054	5								8			
1/19/2009	DH054	4							1.7	9			
2/5/2009	DH054								1.7				
3/25/2009	DH054								1.7				
5/6/2009	DH054								22				
7/30/2009	DH054								4.5				
9/16/2009	DH054								4.5				
1/14/2009	DH055	6								5			
1/19/2009	DH055	4							2	8			
2/5/2009	DH055								2				
3/25/2009	DH055								1.7				
5/6/2009	DH055								33				
7/30/2009	DH055								4.5				
9/16/2009	DH055								4.5				
1/14/2009	DH057	6								8			
1/19/2009	DH057	4							1.7	5			
2/5/2009	DH057								2				
3/25/2009	DH057								1.7				
5/6/2009	DH057								33				
7/30/2009	DH057								7.8				
9/16/2009	DH057								1.7				
1/14/2009	DH058	6								7			
1/19/2009	DH058	4							1.7	8			
2/5/2009	DH058								1.7				
3/25/2009	DH058								1.7				
5/6/2009	DH058								23				
7/30/2009	DH058								2				
9/16/2009	DH058								17				
1/14/2009	DH271	6								9			
1/19/2009	DH271	4							2	2			
2/5/2009	DH271								2				
3/25/2009	DH271								1.7				
5/6/2009	DH271								33				
7/30/2009	DH271								2				
9/16/2009	DH271								33				

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
1/14/2009	DH272	6								4			
1/19/2009	DH272	4								9			
2/5/2009	DH272								1.7				
3/25/2009	DH272								1.7				
5/6/2009	DH272								33				
7/30/2009	DH272								2				
9/16/2009	DH272								13				
1/19/2009	DH285	3							2	7			
3/4/2009	DH285	6							2	2			
5/27/2009	DH285	11							1.7	3			
7/23/2009	DH285									9			
9/23/2009	DH285	21							1.7	6			
10/8/2009	DH285	15							1.7	6			
11/4/2009	DH285	9.5							1.7	4			
1/19/2009	DH286	3							2	9			
3/4/2009	DH286	6							1.7				
5/27/2009	DH286	10							1.7	2			
7/23/2009	DH286	14								3			
9/23/2009	DH286	19.5							4.5	6			
10/8/2009	DH286	15.5							4	6			
11/4/2009	DH286	7							17	9			
1/19/2009	DH287	3							2	2			
3/4/2009	DH287	7							1.7	6			
5/27/2009	DH287	11							1.7	9			
7/23/2009	DH287	14								2			
9/23/2009	DH287	20							1.7	6			
10/8/2009	DH287	14.5							1.7	6			
11/4/2009	DH287	10.5							1.7	3			
1/19/2009	DH288	3							2	8			
3/4/2009	DH288	7							1.7	3			
5/27/2009	DH288	10							1.7	2			
7/23/2009	DH288	14								3			
9/23/2009	DH288	21							1.7	4			
10/8/2009	DH288	14.5							1.7	6			
11/4/2009	DH288	9							4.5	7			
1/5/2009	SW001	6					2	10	2	11			
2/17/2009	SW001	10					1.9	9	1.9	11			
3/24/2009	SW001	8					1.9	9	1.9	11			
4/20/2009	SW001	21					1.9	9	1.9	10			
5/29/2009	SW001	29					1.9	9	1.9	11			
6/15/2009	SW001	19					1.9	9	1.9	2			
7/28/2009	SW001	23					1.9	8.9	1.9	11			
8/27/2009	SW001	21					2	9	2	11			
9/9/2009	SW001	16					6	10	6	11			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
10/7/2009	SW001	14					4	9	4	11			
11/30/2009	SW001	9					6	10	6	11			
1/5/2009	SW002	7					4	9	4	8			
2/17/2009	SW002	9					1.9	9	1.9	8			
3/24/2009	SW002	8					1.9	9	1.9	2			
4/20/2009	SW002	21					1.9	9	20	8			
6/15/2009	SW002	19					1.9	9	1.9	6			
7/28/2009	SW002	24					1.9	9	1.9	6			
8/27/2009	SW002						1.9	9	1.9	8			
9/9/2009	SW002	16					1.9	9	1.9	5			
10/7/2009	SW002	15					1.9	9	1.9	5			
11/30/2009	SW002	9					4	9	4	8			
1/16/2009	SW003	7					18	9	18	11	52.85		
2/26/2009	SW003	1					120	111	120	11			
3/18/2009	SW003	8					54	31	54				
4/30/2009	SW003	15					60	20	60	11	9.09		
5/11/2009	SW003	16					120	10	120	11	5.66		
6/25/2009	SW003	16					86	190	86	11			
7/24/2009	SW003	27					36	42	36	11	2.95		
8/19/2009	SW003	17					30	210	30	11			
10/1/2009	SW003	12					1.9	10	1.9	11			
10/28/2009	SW003	9.5					32	87	32	11			
11/18/2009	SW003	8					170	360	170	11			
12/17/2009	SW003	10					900	782	900	11			
11/17/2009	SW004	13					100	87	100	11			
11/18/2009	SW004	5					230	240	230				
1/5/2009	SW006	9					8	9	8	4			
2/17/2009	SW006	15					1.9	9	1.9	8			
3/24/2009	SW006	7					1.9	9	1.9	2			
4/20/2009	SW006	27					1.9	9	1.9	5			
5/29/2009	SW006	28					1.9	9	1.9	9			
6/15/2009	SW006	24					1.9	9	1.9	9			
7/28/2009	SW006	28					2	10	2	6			
8/27/2009	SW006	26					1.9	9	1.9	5			
9/9/2009	SW006	19.5					2	10	2	6			
10/7/2009	SW006	15					1.9	9	1.9	3			
11/30/2009	SW006	9					22	42	22	7			
1/13/2009	SW007	10					1.9	40	94	11			
3/25/2009	SW007	11					32	10	32	11			
4/16/2009	SW007	19					1.9	9	6	11			
5/6/2009	SW007	11					90	53	90	11			
6/17/2009	SW007	22					26	10	26	11			
7/30/2009	SW007						52	87	52	11			
8/4/2009	SW007	28					1.9	150	70	11			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
10/29/2009	SW007	7					36	42	36	11			
11/19/2009	SW007						220	150	220	11			
12/14/2009	SW007	3					26	10	26	11			
1/16/2009	SW008	6					44	53	50	11	43.42		
2/26/2009	SW008	4					120	53	120	11			
3/18/2009	SW008	8					110	42	110	10			
4/30/2009	SW008	14					96	42	96	10			
5/11/2009	SW008	18					110	10	110				
6/25/2009	SW008	15					620	120	620	11			
7/24/2009	SW008	22					380	75	380	11			
8/19/2009	SW008	18					70	99	70	11			
10/1/2009	SW008	11					20	31	20	10			
10/28/2009	SW008	8					44	110	44	10			
11/18/2009	SW008	8					170	240	170				
12/17/2009	SW008	11					124	164	124	11			
1/16/2009	SW009	11					138	9	138	1			
2/26/2009	SW009	1					98	31	98	1	0		
3/18/2009	SW009	17					1.9	9	12	1	0		
4/30/2009	SW009	26					170	75	170	1	0		
5/11/2009	SW009	12					30	9	30	1	0		
6/25/2009	SW009	23					1200	1400	1200	1	0		
7/24/2009	SW009	25					210	2000	210	1	0		
8/19/2009	SW009	26					60	1999	60	1	0		
10/1/2009	SW009	13					2	64	2	1	0		
10/28/2009	SW009	10					1100	500	1100	1	0		
11/18/2009	SW009	6					180	220	180	11			
12/17/2009	SW009	10.5					44	288	44	1	0		
1/16/2009	SW010	7					4	9	4	11	28.02		
2/26/2009	SW010						42	20	42	11			
3/18/2009	SW010	14					2	9	4	1	0		
4/30/2009	SW010	23					240	120	240	1	0		
5/11/2009	SW010	15					38	10	38	1	0		
6/25/2009	SW010	17					96	87	96	1	0		
7/24/2009	SW010	26					96	380	100	1	0		
8/19/2009	SW010	26					20	1999	20	1	0		
10/1/2009	SW010	14.5					64	250	64	1	0		
10/28/2009	SW010	9.5					8	31	8	1	0		
11/18/2009	SW010	8					190	270	190	1	0		
12/17/2009	SW010	10					2400	254	2400	1	0		
1/16/2009	SW011	7					250	64	250	11	13.4		
2/26/2009	SW011	1					160	164	160	11			
3/18/2009	SW011	10					140	42	140	11	9.375		
4/30/2009	SW011	21					600	140	600	11	0.95		
5/11/2009	SW011	13					26	10	26	11	8.16		

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
6/25/2009	SW011	17					2400	2000	2400	11			
7/24/2009	SW011	22					1200	42	1200	1	0		
8/19/2009	SW011	19					140	64	140	1	0		
10/1/2009	SW011	11					300	480	300	1	0		
10/28/2009	SW011	9					220	190	220	11			
11/18/2009	SW011	8					130	500	130	11			
12/17/2009	SW011	11					1060	478	1060	11			
1/16/2009	SW012	11					4	9	4	11	30		
2/26/2009	SW012	1					210	207	210	11			
3/18/2009	SW012	15					8	20	46	11	7.85		
4/30/2009	SW012	26					1.9	9	170	11	0.44		
5/11/2009	SW012	16					150	430	150	11	16.5		
6/25/2009	SW012	19					130	240	130	1	0		
7/24/2009	SW012	27					1.9	75	30	1	0		
8/19/2009	SW012	27					56	270	56	1	0		
10/1/2009	SW012	15					76	110	76	1	0		
10/28/2009	SW012	9					10	110	10	11			
11/18/2009	SW012	7					24	64	24	11			
12/17/2009	SW012	10					860	945	860	11			
1/16/2009	SW013	9					16	99	16	11	22.5		
2/26/2009	SW013	1					18	75	18	1	0		
3/18/2009	SW013	16					1.9	53	30				
4/30/2009	SW013	26					1.9	140	42	1	0		
5/11/2009	SW013	11					730	660	730				
6/25/2009	SW013	20					1.9	150	110	1	0		
7/24/2009	SW013	27					4.9	2000	4.9	1	0		
8/19/2009	SW013	27					2.9	1999	53	1	0		
10/1/2009	SW013	14					30	180	30	10			
10/28/2009	SW013	9.5					220	410	220	1	0		
11/18/2009	SW013	6.5					1.9	120	80	1	0		
12/17/2009	SW013	10					172	254	172	1	0		
1/16/2009	SW014	9					34	9	34	11	1.33		
2/26/2009	SW014	2					30	75	30	11	3		
3/18/2009	SW014	9					4	9	4	11	1.8		
4/30/2009	SW014	19					400	99	400	11	0.88		
5/11/2009	SW014	15					750	890	750	11	4.73		
6/25/2009	SW014	18					1200	2000	1200	1	0		
8/19/2009	SW014	22					1.9	100	40	1	0		
10/1/2009	SW014	13					2400	2000	2400	10			
10/28/2009	SW014	10					50	75	50	11			
11/18/2009	SW014	8					14	10	14	11			
12/17/2009	SW014	11.5					200	75	200	11			
2/11/2009	SW015	6					4	10	4	11			
3/27/2009	SW015	14					1.9	87	2	1	0		

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
4/22/2009	SW015	20					160	75	160	11	1.44		
5/5/2009	SW015	15					2	10	150	1	0		
6/1/2009	SW015	29					38	9	38	1	0		
7/29/2009	SW015	30					14	140	14	1	0		
8/18/2009	SW015	30					1.9	87	14	1	0		
9/30/2009	SW015	15					2	31	2	1	0		
10/26/2009	SW015	10	54	0.05	3.5	5.3	62	53	62	1	0	1.6	0.15
11/17/2009	SW015	10					200	140	200	11			
12/28/2009	SW015	5					1.9	20	1.9	11			
1/13/2009	SW016	10					18	40	18	1			
2/11/2009	SW016	10					2	20	2	11			
3/27/2009	SW016	12					1.9	9	1.9				
4/22/2009	SW016	21					1.9	9	1.9	11			
5/5/2009	SW016	13					1.9	9	1.9	1	0		
6/1/2009	SW016	29					2	9	2	1	0		
11/17/2009	SW016	10					760	380	760	1	0		
2/11/2009	SW017	10					230	700	230	11			
3/27/2009	SW017	16					1.9	9	1.9				
4/22/2009	SW017	21					1.9	9	1.9	1	0		
5/5/2009	SW017	12					1.9	10	12				
6/1/2009	SW017	26					2	9	2	1	0		
10/26/2009	SW017	14					58	450	58	1	0		
11/17/2009	SW017	10					60	140	74	11			
12/28/2009	SW017	8					2	9	2	1	0		
1/13/2009	SW018	11					48	30	48	11			
1/5/2009	SW019	11					8	9	8				
2/17/2009	SW019	13					1.9	9	1.9	11			
3/24/2009	SW019	7					2	9	2	4			
4/20/2009	SW019	22					2	9	2	4			
5/29/2009	SW019	25					1.9	9	1.9	11			
6/15/2009	SW019	18					1.9	10	1.9	2			
7/28/2009	SW019	24					4	53	4	4			
8/27/2009	SW019						6	9	6	8			
9/9/2009	SW019	15.5					22	190	22	8			
10/7/2009	SW019	16					2	9	2				
11/30/2009	SW019	9.5					6	10	6	8			
1/5/2009	SW022	8					42	75	42	8			
2/17/2009	SW022	11					1.9	9	1.9	8			
3/24/2009	SW022	7					1.9	9	1.9	4			
4/20/2009	SW022	21					1.9	9	1.9	3			
6/15/2009	SW022	21					1.9	9	1.9	6			
7/28/2009	SW022	24					2	9	2	5			
8/27/2009	SW022						1.9	9	1.9	4			
9/9/2009	SW022	15					4	9	4	8			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
10/7/2009	SW022	15					1.9	9	1.9	2			
11/30/2009	SW022	9					6	10	6	8			
1/5/2009	SW023	11					2	9	2	9			
2/17/2009	SW023	14					2	9	2	4			
3/24/2009	SW023	8					1.9	9	1.9	8			
4/20/2009	SW023	17					2	20	2	5			
5/29/2009	SW023	21					1.9	9	1.9	4			
6/15/2009	SW023	25					1.9	9	1.9	8			
7/28/2009	SW023	26					4	9	4	6			
8/27/2009	SW023	24					1.9	9	1.9	5			
9/9/2009	SW023	24.5					4	20	4	7			
10/7/2009	SW023	16					1.9	9	1.9	5			
11/30/2009	SW023	9					130	150	130	7			
1/5/2009	SW024	9					14	9	14	11	0.0618		
1/5/2009	SW025	9					8	9	8	11	0.0224		
1/5/2009	SW026	10					43	19.5	43	11	1.27		
2/17/2009	SW026	15					6.95	9	6.95	7.5	0.09877		
3/24/2009	SW026	8					10.95	9.5	10.95	9.5	1.586		
4/20/2009	SW026	22.5					3	9.5	3	6	0.019		
5/29/2009	SW026	25					152	14.5	152	8	0.156		
11/30/2009	SW026	9.25					52	69.5	52	9			
1/5/2009	SW027	9.5					40	10	40	11	2.8		
2/17/2009	SW027	14					11	9.5	11	7.5	2.04557		
3/24/2009	SW027	7					34	9.5	34	6.5	0.678		
4/20/2009	SW027	22.5					9	9	9	10	0.332		
5/29/2009	SW027	22					48.5	33	45	8	0.21		
6/15/2009	SW027	18					381	129.5	381	10			
11/30/2009	SW027	9					208	37	208	9			
1/5/2009	SW028	8					114	9	114	11	3.78		
2/17/2009	SW028	13					3.95	9	3.95	7.5	0.166		
3/24/2009	SW028	7					58	9	58	6.5	4.029		
4/20/2009	SW028	22					24	9	24	7.5	0.07		
5/29/2009	SW028	27					225	9.5	225	8	0.0625		
6/15/2009	SW028	22					40	9.5	40	1	0		
7/28/2009	SW028	29					210	20	210	3.5	0		
8/27/2009	SW028	24					1.95	9	1.95	3	0		
9/9/2009	SW028	19.75					144	58.5	144	7.5			
10/7/2009	SW028	15					14	64	14	8			
11/30/2009	SW028	9.25					70	53	70	8.5			
3/25/2009	SW029	12					8	9	8	11			
4/16/2009	SW029	20					16	31	16	11	1.36		
5/6/2009	SW029	10					300	9	300	11	0.2		
10/29/2009	SW029	7					8	20	8	11			
11/19/2009	SW029	5					72	87	72	11			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
12/14/2009	SW029	3					14	9	14	11			
1/8/2009	SW030	8								3			
1/12/2009	SW030						90	75	90	8			
2/5/2009	SW030	9					6	9	6	4			
3/25/2009	SW030	13					1.9	9	1.9	2			
4/16/2009	SW030	18					1.9	9	1.9	2			
5/6/2009	SW030	11					16	10	16	8			
6/17/2009	SW030						2	9	2	8			
7/30/2009	SW030						18	10	18	6			
8/4/2009	SW030	27					2	9	2	6			
9/16/2009	SW030	19					1.9	31	4	8			
10/29/2009	SW030	7					24	87	24	2			
11/19/2009	SW030						140	380	140	2			
12/14/2009	SW030	4					10	9	10	8			
1/8/2009	SW031	10								11	1.66		
1/12/2009	SW031	7					1.9	9	6	11	0.83		
2/5/2009	SW031	11					2	10	2	11	0.077		
3/25/2009	SW031	15					2	9	2	11	0.047		
4/16/2009	SW031	19					1.9	9	1.9	11			
5/6/2009	SW031	11					12	9	12	11			
1/8/2009	SW032	9								9			
1/12/2009	SW032	7					1.9	53	32	8			
2/5/2009	SW032	8					1.9	9	1.9	2			
3/25/2009	SW032	15					1.9	9	1.9				
4/16/2009	SW032	19					1.9	10	10	2			
5/6/2009	SW032	11					32	10	32	6			
6/17/2009	SW032	19					1.9	9	1.9	8			
7/30/2009	SW032						4	9	4	4			
8/4/2009	SW032	27					1.9	10	1.9	6			
9/16/2009	SW032	17					1.9	9	1.9	9			
10/29/2009	SW032	8					38	75	38	8			
11/19/2009	SW032						72	290	72	2			
12/14/2009	SW032	4					12	10	12	8			
1/8/2009	SW033	8								11	1.45		
1/12/2009	SW033	7					20	9	20	11	0.94		
2/5/2009	SW033	11					6	945	6	11	0.259		
3/25/2009	SW033	12					4	10	4	11	0.145		
4/16/2009	SW033	22					1.9	9	4	11			
5/6/2009	SW033	11					230	10	230	11			
11/19/2009	SW033						1600	2000	1600	11			
1/12/2009	SW034	7					42	99	42	9			
2/5/2009	SW034	11					1.9	9	1.9	4			
3/25/2009	SW034	12					1.9	9	1.9	2			
4/16/2009	SW034	22					1.9	9	36	3			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
5/6/2009	SW034	10					1.9	31	42	6			
6/17/2009	SW034	19					2	9	2	8			
7/30/2009	SW034						1.9	9	1.9	4			
8/4/2009	SW034	26					1.9	10	1.9	6			
9/16/2009	SW034	15					8	9	8	9			
10/29/2009	SW034						28	53	28	9			
11/19/2009	SW034						56	180	56	3			
12/14/2009	SW034	4					2	9	2	8			
1/12/2009	SW035	7					2	10	2	11	0.1		
2/5/2009	SW035	12					1.9	9	1.9	11			
3/25/2009	SW035	9					1.9	31	150	11	0.198		
4/16/2009	SW035	15					1.9	9	1.9	11	0.004		
5/6/2009	SW035	12					40	20	40	11			
11/19/2009	SW035	20.5					68	190	68	11			
1/12/2009	SW036	7					4	53	56	9			
2/5/2009	SW036	9					1.9	9	2	7			
3/25/2009	SW036	9					1.9	9	1.9	7			
4/16/2009	SW036	15					1.9	9	8				
5/6/2009	SW036	12					32	10	32	7			
6/17/2009	SW036	17					760	9	760	8			
7/30/2009	SW036						1.9	9	1.9	4			
8/4/2009	SW036	26					1.9	9	1.9				
9/16/2009	SW036	15					10	64	10	2			
10/29/2009	SW036	6					16	64	16	9			
11/19/2009	SW036	20.5					52	110	52	3			
12/14/2009	SW036	3					4	87	4	8			
1/12/2009	SW037	7					16	42	16	11	0.016		
4/16/2009	SW037	19					1.9	9	1.9	11			
11/19/2009	SW037	20					1600	2000	1600	11	0.0637		
1/12/2009	SW038	7					58	111	58	9			
2/5/2009	SW038	8					1.9	9	1.9	2			
3/25/2009	SW038	11					1.9	9	1.9	7			
4/16/2009	SW038	23					1.9	9	1.9	9			
5/6/2009	SW038	12					24	20	24	7			
6/17/2009	SW038	18					74	9	74	9			
7/30/2009	SW038						1.9	9	1.9	3			
8/4/2009	SW038	23					1.9	10	1.9	6			
9/16/2009	SW038	17					2	31	2	2			
10/29/2009	SW038	7					28	87	28	9			
11/19/2009	SW038	20					60	120	60	9			
12/14/2009	SW038	4					1.9	9	1.9	8			
1/12/2009	SW039	7					6	10	6	2			
2/5/2009	SW039	10					2	9	2	7			
3/25/2009	SW039	7					1.9	9	1.9	4			
4/16/2009	SW039	9					8	9	8	5			
5/6/2009	SW039	12					6	9	6	2			
6/17/2009	SW039	18					4	53	4	8			
7/30/2009	SW039						2	31	2	4			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
8/4/2009	SW039	20					1.9	9	1.9	3			
9/16/2009	SW039	17					34	42	34	2			
10/29/2009	SW039	8					6	20	6	4			
11/19/2009	SW039						74	450	74	2			
12/14/2009	SW039	4					2	10	2	8			
1/13/2009	SW051	12					124	64	124	11	570		
1/16/2009	SW051	4					52	30	52	10			
2/11/2009	SW051	4					1.9	137	66	11			
2/26/2009	SW051	4					56	20	56	11			
3/18/2009	SW051	8					2	9	4	10			
3/27/2009	SW051	9					1.9	9	1.9	10			
4/22/2009	SW051	12					6	10	6	11			
4/30/2009	SW051	15					4	9	4	10			
5/5/2009	SW051	13					10	20	10	10			
5/11/2009	SW051	17					300	110	300				
6/1/2009	SW051	21					1.9	10	1.9				
6/25/2009	SW051	16					1.9	20	22				
7/24/2009	SW051	19					2	42	2	11	133.3		
7/29/2009	SW051	27					1.9	9	2	10			
8/18/2009	SW051	20					10	9	10	11			
8/19/2009	SW051	16					36	9	36	11			
9/30/2009	SW051	15					2	9	2	10			
10/1/2009	SW051	10					1.9	9	1.9	10			
10/26/2009	SW051	9.5					10	190	10	10			
10/28/2009	SW051	8					16	110	16	10			
11/17/2009	SW051	8.5					12	9	12	10			
11/18/2009	SW051	7					1.9	190	40				
12/17/2009	SW051	9					220	53	220	11			
12/28/2009	SW051	5					260	99	260	11			
1/13/2009	SW052	9					2	9	2				
2/11/2009	SW052	6					1.9	9	1.9	4			
3/27/2009	SW052	9					1.9	9	1.9				
4/22/2009	SW052	12					1.9	9	1.9	4			
5/5/2009	SW052	14					62	75	62	2			
6/1/2009	SW052	28					1.9	9	1.9	2			
7/29/2009	SW052	32					1.9	9	1.9	3			
8/18/2009	SW052	28					1.9	10	1.9	4			
9/30/2009	SW052	16					1.9	9	1.9	3			
10/26/2009	SW052	14					1.9	10	1.9	4			
11/17/2009	SW052	9					1.9	8.9	1.9	3			
12/28/2009	SW052	5					28	9	28	8			
1/16/2009	SW053	9					12	10	12	11			
2/26/2009	SW053	2					182	111	182	11			
3/18/2009	SW053	7					56	10	56	11			
4/30/2009	SW053	19					1.9	9	4	11			
5/11/2009	SW053	16					420	210	420	11			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
6/25/2009	SW053	18					1.9	53	6	11			
7/24/2009	SW053	23					14	20	14	11			
8/19/2009	SW053	20					160	20	160	11			
10/1/2009	SW053	12.5					8	10	8	4			
10/28/2009	SW053	9					56	140	56	1	0		
11/18/2009	SW053	6					44	180	44				
12/17/2009	SW053	11					4	20	4	1	0		
1/13/2009	SW055	11					252	20	252	11			
2/11/2009	SW055	13					1.9	9	60	1	0		
3/27/2009	SW055	9					10	31	10	11			
4/22/2009	SW055	14					2	9	2	11			
5/5/2009	SW055	16					4	9	4	11			
6/1/2009	SW055	26					8	10	8	1	0		
7/29/2009	SW055	25					1.9	9	4	11			
8/18/2009	SW055	23					4	9	4	11			
9/30/2009	SW055	17					1.9	10	1.9	11			
10/26/2009	SW055	11.5					10	20	10	1	0		
11/17/2009	SW055	8.5					86	110	86	11			
12/28/2009	SW055	7					10	10	10	11			
1/13/2009	SW056	10					118	30	118	11	900.9		
2/11/2009	SW056	6					1.9	9	40	11			
3/27/2009	SW056	10					22	10	22				
4/22/2009	SW056	12					80	64	80	10			
5/5/2009	SW056	13					62	75	62	11			
6/1/2009	SW056	23					10	10	10				
7/29/2009	SW056	30					1.9	9	1.9	1	0		
8/18/2009	SW056	25					18	9	18	1	0		
9/30/2009	SW056	18					4	9	4	11			
10/26/2009	SW056	11					18	42	18	11			
11/17/2009	SW056	10					150	270	150	10			
12/28/2009	SW056	5					390	64	390	1	0		
1/16/2009	SW058	9					88	9	88	1			
2/26/2009	SW058						12	53	12	1	0		
3/18/2009	SW058	16					1.9	10	4	1	0		
4/30/2009	SW058	27					1.9	1600	280	1	0		
5/11/2009	SW058	11					36	9	36	1	0		
6/25/2009	SW058	22					26	87	26	1	0		
10/28/2009	SW058	10					2.9	240	120	1	0		
11/18/2009	SW058	5.5					150	140	150				
12/17/2009	SW058	10					146	178	146	1	0		
2/11/2009	SW059	6					42	9	42	11			
3/27/2009	SW059	10					8	20	8	11	14.28		
4/22/2009	SW059	16					74	140	74	11			
5/5/2009	SW059	13					180	75	180	11			
6/1/2009	SW059	26					1.9	10	34	1	0		
7/29/2009	SW059	28					88	180	88	1	0		
8/18/2009	SW059	25					1.9	10	14	1	0		
9/30/2009	SW059	13					56	120	56	11			
10/26/2009	SW059	11					86	450	86	10			

Table A.1 2009 Selected Water Quality Results

Run Date	Site Number	Air Temperature (deg C)	Alkalinity (mg/l)	Ammonia (mg/l)	Biochemical Oxygen Demand (mg/l)	Chlorophyll a (ug/l)	E_ coli (cfu/100ml)	Enterococcus (cfu/100ml)	Fecal Coliform (cfu/100ml)	Flow - Direction (None)	Flow (cfs)	Iron (mg/l)	Nitrate (mg/l)
11/17/2009	SW059	10					56	20	56	11			
12/28/2009	SW059	5					12	10	12	11			
1/13/2009	SW072	10					116	400	116	1			
2/11/2009	SW072	7					8	10	8	1	0		
3/27/2009	SW072	12					10	9	10				
4/22/2009	SW072	18					1.9	9	2	1	0		
5/5/2009	SW072	15					1.9	9	2	2			
6/1/2009	SW072	29					2	9	150	1	0		
7/29/2009	SW072	29					100	42	100	1	0		
8/18/2009	SW072	24					50	31	50	1	0		
9/30/2009	SW072	14					28	9	28	1	0		
10/26/2009	SW072	11					70	1200	70	1	0		
11/17/2009	SW072	10.5					6	31	6	1	0		
1/12/2009	SW118	12					120	64	120	11			
1/16/2009	SW118	8					40	9	40	11			
2/5/2009	SW118	8					38	9	38	11			
2/11/2009	SW118	8					14	9	14	11			
2/26/2009	SW118	0					220	87	220	11			
3/18/2009	SW118	12					26	20	78	11			
3/25/2009	SW118	12					1.9	9	14	11			
3/27/2009	SW118	13					2	10	2	11			
4/16/2009	SW118	19					1.9	9	1.9	11			
4/22/2009	SW118	18					42	20	42	11			
4/30/2009	SW118	20					10	9	10	11			
5/5/2009	SW118	12					18	9	18	11			
5/6/2009	SW118	10					76	10	76	11			
5/11/2009	SW118	10					1.9	9	1.9	11			
6/1/2009	SW118	25					2	9	34	11			
6/17/2009	SW118	24					24	20	24	11			
6/25/2009	SW118	19					48	31	48	11			
7/24/2009	SW118	27					10	87	10	11			
7/29/2009	SW118						72	87	72	11			
7/30/2009	SW118						52	87	52	11			
8/4/2009	SW118	25					74	64	74	11			
8/18/2009	SW118	25					24	20	24	11			
8/19/2009	SW118	29					130	53	130	11			
9/16/2009	SW118						34	87	34	11			
9/30/2009	SW118	12					16	31	16	11			
10/1/2009	SW118	14					58	75	58	11			
10/26/2009	SW118	12					90	190	90	11			
10/28/2009	SW118	10					92	99	92	11			
10/29/2009	SW118	7					52	150	52	11			
11/19/2009	SW118						170	110	170	11			
12/14/2009	SW118	2					20	9	20	11			
12/17/2009	SW118	10					260	344	260	11			
12/28/2009	SW118	18					18	10	18	11			

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
1/19/2009	DH038			105.7	10.73		7.64		6.58	28.74	164.59		45062
3/4/2009	DH038			94.8	9.675		7.68		6.335	28.65	6.1		44968
5/27/2009	DH038			118.1	10.49		8.07		11.36	28.74	137.16		44596
7/23/2009	DH038			104.3	8.68		8.2		16.67	25.64	106.68		40076
9/23/2009	DH038			89.55	7.745		7.845		13.335	30.385	125		46783.5
10/8/2009	DH038			79.3	7.21		7.74		11.05	30.19	131.06		46645
11/4/2009	DH038			75.65	7.205		7.685		9.1	29.18	158.5		45395
1/19/2009	DH039			106.6	10.78		7.65		6.71	28.77	228.6		45081
3/4/2009	DH039			92.3	9.33		7.62		6.59	29.08	8.4		45534
5/27/2009	DH039			114.1	10.57		8		10.62	28.77	201.168		44692
7/23/2009	DH039			102.7	8.57		8.19		16.53	26.1	85.34		40729
9/23/2009	DH039			83.6	7.35		7.89		12.5	30.49	177		46977
10/8/2009	DH039			77.5	7.02		7.75		11.05	30.16	204.22		46613
11/4/2009	DH039			71.2	6.74		7.68		9.31	29.45	216.4		45754
1/19/2009	DH040			105.1	10.71		7.62		6.49	28.75	185.93		45084
3/4/2009	DH040			91.3	9.19		7.63		6.77	29.26	6.6		45765
5/27/2009	DH040			108.2	10		7.99		10.7	28.75	161.544		44654
7/23/2009	DH040			109.2	9.375		8.125		14.905	26.32	88.39		41054.5
9/23/2009	DH040			84.6	7.49		7.84		12.2	30.4	152		46862
10/8/2009	DH040			78.4	7.11		7.75		11.21	30.01	152.4		46382
11/4/2009	DH040			69.9	6.62		7.66		9.49	29.03	155.5		45148
1/19/2009	DH041			105.4	10.74		7.63		6.39	28.73	170.69		45076
3/4/2009	DH041			89.8	9.03		7.64		6.76	29.32	5.9		45866
5/27/2009	DH041			107.55	9.94		7.98		10.755	28.76	143.256		44669
7/23/2009	DH041			106.6	8.95		8.14		16.06	26.25	42.67		40937
9/23/2009	DH041			78.8	6.88		7.76		13.04	30.3	140		46684
10/8/2009	DH041			72.8	6.61		7.69		11.15	30.12	137.16		46548
11/4/2009	DH041			69.2	6.57		7.64		9.35	29.3	164.6		45546
1/19/2009	DH042			103.4	10.63		7.6		6.11	28.37	67.06		44597
3/4/2009	DH042			102.1	10.31		7.83		6.74	29.01	6.3		45415
5/27/2009	DH042			109.1	9.87		8.01		11.68	28.78	143.256		44637
7/23/2009	DH042			112.8	9.47		8.22		16.05	26.35	60.96		41071
9/23/2009	DH042			57	4.85		7.55		13.93	30.37	165		46747
10/8/2009	DH042			75	6.81		7.67		11.13	30.1	158.5		46525
11/4/2009	DH042			70.6	6.88		7.62		8.33	28.35	176.8		44297
1/19/2009	DH043			110.05	11.515		7.66		5.57	27.74	190		43775
3/4/2009	DH043			90.5	9.15		7.67		6.71	29.15	7		45635
5/27/2009	DH043			116.9	10.65		8.04		11.38	28.7	185.928		44542
7/23/2009	DH043			143.6	12.11		8.29		15.47	27.13	143.3		42174
9/23/2009	DH043			84.1	7.2		7.79		13.9	30.32	198		46678
10/8/2009	DH043			88.2	7.94		7.77		11.39	30	185.9		46361
11/4/2009	DH043			70.5	6.7		7.61		9.25	29.05	213.4		45205
1/19/2009	DH044								4.4	25			39940
3/4/2009	DH044			111.4	11.16		8.06		7.34	27.88			43742

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
5/27/2009	DH044			104.1	8.45		8.24		16.82	29.32	45.72		45216
7/23/2009	DH044			93.2	6.78		8.47		22.53	30.12			46351
9/23/2009	DH044			87.6	6.645		7.78		19.995	30.665			47070
10/8/2009	DH044			107.9	9.18		8.04		14.04	30.81			47344
11/4/2009	DH044			96.4	9.33		7.87		9.01	27.6			43180
1/19/2009	DH045								4.5	25.1			40150
3/4/2009	DH045			112	11.25		8.08		7.04	28.01			43962
5/27/2009	DH045			145.45	12.14		8.295		15.59	29.045	9.144		44853.5
7/23/2009	DH045			184.8	13.825		8.91		21.415	28.52			44114
9/23/2009	DH045			83	6.42		7.67		18.99	30.56			46919
10/8/2009	DH045			100.2	8.775		7.86		12.75	30.885			47514
11/4/2009	DH045			134.25	12.915		8.29		9.175	27.825			43475
1/14/2009	DH048			84.5	8.58		7.64		6.68	27.78	231.14		36622
1/19/2009	DH048			85.75	8.63		7.66		6.76	28.545	300		44770
2/5/2009	DH048									25			
5/6/2009	DH048									28			
7/30/2009	DH048									20			
9/16/2009	DH048									22			
1/14/2009	DH049			97	11.505		7.545		5.4	9.24	66.04		15945.5
1/19/2009	DH049			86.4	8.8		7.65		6.53	28.34	500		44493
2/5/2009	DH049									15			
3/25/2009	DH049									28			
5/6/2009	DH049									0			
7/30/2009	DH049									10			
9/16/2009	DH049									22			
1/14/2009	DH050			96.4	11.36		7.54		5.54	9.56			16447
1/19/2009	DH050			82.4	8.4		7.61		6.53	28.16	91.44		44243
2/5/2009	DH050									10			
3/25/2009	DH050									26			
5/6/2009	DH050									0			
7/30/2009	DH050									14			
9/16/2009	DH050									15			
1/14/2009	DH051			95.5	11.46		7.46		5.43	7.38	43.18		12945
1/19/2009	DH051			81.8	8.35		7.61		6.53	28.24	100.58		44357
2/5/2009	DH051									8			
3/25/2009	DH051									28			
5/6/2009	DH051									0			
7/30/2009	DH051									18			
9/16/2009	DH051									18			
1/14/2009	DH052			94.4	11.43		7.38		5.61	5.63			10094
1/19/2009	DH052			89.6	9.31		7.67		6.05	27.18	15.24		42909
2/5/2009	DH052									5			
3/25/2009	DH052									28			
5/6/2009	DH052									0			

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
7/30/2009	DH052									20			
9/16/2009	DH052									18			
1/14/2009	DH053			94.4	11.3		7.56		5.5	10.36	76.2		17720
1/19/2009	DH053			89	9.84		7.64		4.64	22.82	170		37762
2/5/2009	DH053									24			
3/25/2009	DH053									25			
5/6/2009	DH053									0			
7/30/2009	DH053									18			
9/16/2009	DH053									25			
1/14/2009	DH054			94.8	11.24		7.51		5.47	9.13	52.07		15772
1/19/2009	DH054			97.8	11.17		7.71		4.3	22.375	60		30720
2/5/2009	DH054									12			
3/25/2009	DH054									25			
5/6/2009	DH054									0			
7/30/2009	DH054									18			
9/16/2009	DH054									25			
1/14/2009	DH055			94.9	11.33		7.52		5.36	8.62	52.07		14947
1/19/2009	DH055			85.2	9.19		7.62		5.03	25.17	170		40158
2/5/2009	DH055									10			
3/25/2009	DH055									25			
5/6/2009	DH055									0			
7/30/2009	DH055									18			
9/16/2009	DH055									24			
1/14/2009	DH057			93.8	11.28		7.43		5.66	6.165	43.18		10936
1/19/2009	DH057			101.8	10.71		7.61		5.71	26.66	220		42210
2/5/2009	DH057									5			
3/25/2009	DH057									28			
5/6/2009	DH057									0			
7/30/2009	DH057									18			
9/16/2009	DH057									20			
1/14/2009	DH058			95.5	10.795		7.45		5.61	8.02	46.99		13965
1/19/2009	DH058			102.2	10.57		7.54		6.16	27.3	137.16		43058
2/5/2009	DH058									8			
3/25/2009	DH058									28			
5/6/2009	DH058									0			
7/30/2009	DH058									18			
9/16/2009	DH058									18			
1/14/2009	DH271			96.2	11.69		7.46		5.49	5.2	43.18		9328
1/19/2009	DH271			82.2	8.38		7.64		6.52	28.22	185.93		44323
2/5/2009	DH271									8			
3/25/2009	DH271									28			
5/6/2009	DH271									0			
7/30/2009	DH271									18			
9/16/2009	DH271									18			

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
1/14/2009	DH272			93	10.97		7.5		5.46	10.09	60.96		17273
1/19/2009	DH272			85.1	8.67		6.61		7.65	28.28	140.21		44409
2/5/2009	DH272									10			
3/25/2009	DH272									26			
5/6/2009	DH272									0			
7/30/2009	DH272									10			
9/16/2009	DH272									16			
1/19/2009	DH285			109.1	11.36		7.7		5.7	28.02	85.34		44155
3/4/2009	DH285			101.2	10.69		7.84		5.89	25.56	4		40614
5/27/2009	DH285			115.7	10.1		8.26		13.68	28.3	90		43872
7/23/2009	DH285			95.3	7.64		8.26		18.68	26.28	125		40962
9/23/2009	DH285			86.4	7.59		7.81		12.9	30.36	116		46804
10/8/2009	DH285			74.5	6.8		7.67		10.93	30.16	91.44		46628
11/4/2009	DH285			72.4	6.9		7.66		9.1	29.36	128		45646
1/19/2009	DH286			117.6	12.31		7.7		5.37	28.05	54.86		44239
3/4/2009	DH286			89.6	9.06		7.73		6.62	29.68	2.3		46407
5/27/2009	DH286			105.8	9.55		7.95		11.94	28.41	45.72		44102
7/23/2009	DH286								17.1	27.05	35.58		
9/23/2009	DH286			56.9	4.8		7.56		14.63	30.43	40		46806
10/8/2009	DH286			73.3	6.92		7.6		9.17	29.99	36.8		46512
11/4/2009	DH286			76.3	7.73		7.19		6.89	27.55	76.2		43330
1/19/2009	DH287			107.7	10.98		7.66		6.54	28.7	155.45		45012
3/4/2009	DH287			99.9	10.26		7.79		6.32	28.31	6.3		44483
5/27/2009	DH287			114.9	10.35		8.1		12.09	28.45	160		44146
7/23/2009	DH287			103.2	8.52		8.19		16.9	25.8	109.73		40292
9/23/2009	DH287			77.7	6.88		7.75		12.42	30.35	134		46782
10/8/2009	DH287			75.3	6.83		7.74		11.155	30.125	134.11		46555
11/4/2009	DH287			74.4	7.11		7.69		9.08	29.17	149.4		45389
1/19/2009	DH288			114.95	12.205		7.705		4.99	27.79	64.01		43947
3/4/2009	DH288			97.4	9.87		7.83		7.63	29.2	2.9		45750
5/27/2009	DH288			108.2	9.88		7.99		11.29	28.77	60.96		44648
7/23/2009	DH288			96.7	8.23		8.04		15.33	26.23	64.01		40925
9/23/2009	DH288			80	7		7.76		13.04	30.35	61		46780
10/8/2009	DH288			70.8	6.46		7.6		10.86	30.17	70.1		46643
11/4/2009	DH288			73.2	7.01		7.63		8.95	29.93	76.2		45479
1/5/2009	SW001			100.75	10.93		7.53		3.98	28.15	180		44610
2/17/2009	SW001			106.9	10.94		7.57		5.97	29.47	290		46184
3/24/2009	SW001			103.6	10.42		7.73		6.96	28.68	280		44924
4/20/2009	SW001			138.6	12.6		8.05		11.48	29.04	280		45012
5/29/2009	SW001			109.9	9.08		7.94		15.94	28.83	210		44541
6/15/2009	SW001			129.85	10.3					28.955	230		44697.5
7/28/2009	SW001			101.6	8.24		7.88		17.88	28.14	220		43563
8/27/2009	SW001			123.7	10.39		8.01		15.35	29.58	210		45623
9/9/2009	SW001			92.4	7.84		7.67		14.64	28.92	240		44697

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
10/7/2009	SW001			77.5	6.93		7.15		11.96	29.69	200		45887
11/30/2009	SW001			84.3	8.41		7.59		8.25	25.21	170		39833
1/5/2009	SW002			103.8	10.68		7.72		5.64	30.07	91.44		47093
2/17/2009	SW002			112.5	11.48		7.8		6.15	29.17	94.5		45725
3/24/2009	SW002			110.7	11.12		7.7		6.86	29.36	210		45960
4/20/2009	SW002			177.1	16.13		8.35		11.38	28.67	73.15		44512
6/15/2009	SW002			194.3	28.15					28.16	54.9		43618
7/28/2009	SW002			153.8	12.72		8.2		16.13	28.62	143.26		44244
8/27/2009	SW002			149.2	12.53		8.27		15.19	29.78	176.78		45880
9/9/2009	SW002			104.4	8.97		7.88		13.9	29.82	128		45989
10/7/2009	SW002			85.95	7.74		7.83		11.565	29.95	134.11		46279.5
11/30/2009	SW002			89.85	8.86		7.685		8.42	26.49	140		41652.5
1/16/2009	SW003			68.4	8.97		6.49		4.05	0.11			230
2/26/2009	SW003			87	12.41		6.98		0.78	0.26			500
3/18/2009	SW003			92.1	11.63		6.91		5.51	0.1			199
4/30/2009	SW003			59.8	6.3		6.86		12.84	0.96			1857
5/11/2009	SW003			76.65	8.12		6.98		12.67	0.3			622
6/25/2009	SW003			22.1	1.87					15.4			25195
7/24/2009	SW003			34.9	2.6		7.85		21.38	29.2			45051
8/19/2009	SW003			18.9	1.37		7.5		21.94	30.71			47144
10/1/2009	SW003			28.9	2.99		7.35		13.5	30.94			47558
10/28/2009	SW003			53.5	6.19		6.71		8.515	1.765			3350
11/18/2009	SW003			68.5	8.31		7.15		6.93	0.24			499
12/17/2009	SW003			88.1	12.1		7.73		2.2	0.07			156
11/17/2009	SW004			98.1	12.89		6.89		6.07	0.02			44
11/18/2009	SW004			99.7	12.72		6.82		5.13	0.03			75
1/5/2009	SW006			106.4	11.66		7.78		4.23	26.15	90		41130
2/17/2009	SW006			110.8	11.75		7.71		5.66	25.21	220		40117
3/24/2009	SW006			115.1	11.72		7.78		6.78	27.67	180		43507
4/20/2009	SW006			130.9	13.44		8.16		11.77	8.38	170		14412
5/29/2009	SW006			112.1	9.94		8.04		14.47	16.9	201.77		27217
6/15/2009	SW006			115.1	10					17.36	130		28141
7/28/2009	SW006			119.9	9.745		8.17		19.465	20.705	210		32976.5
8/27/2009	SW006			106.1	8.86		8.09		16.37	26.21	290		40869
9/9/2009	SW006			102.75	8.885		7.95		15.26	24.305	210		38178
10/7/2009	SW006			85.5	7.92		7.77		11.64	25.41	280		39902
11/30/2009	SW006			111.2	11.68		7.66		7.95	18.57	70		30154
1/13/2009	SW007			98	12.44		6.72		5.22	0.05			101
3/25/2009	SW007			104	12.68		7.4		6.8	0.06			119
4/16/2009	SW007			110.6	12.63		9.49		7.53	0.05			106
5/6/2009	SW007			105.75	13.075		7.355		6.25	0.03			57
6/17/2009	SW007			104.05	10.86					0.03			73
7/30/2009	SW007			105.6	9.67		7.73		19.615	0.03			71
8/4/2009	SW007			108.1	10.2		7.8		18.1	0.04			83

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
10/29/2009	SW007			105.4	12.77		7.79		6.94	0.05			98
11/19/2009	SW007			96.45	12.08		7.485		5.835	0.04			83
12/14/2009	SW007			98.8	13.83		8		1.51	0.06			134
1/16/2009	SW008			72	9.33		7.03		4.36	0.27			561
2/26/2009	SW008			79.4	10.91		7.36		1.94	1.16			2300
3/18/2009	SW008			99.9	12.03		7.3		6.37	1.2			2330
4/30/2009	SW008			60.6	5.56		7.41		16.59	15.21			24839
5/11/2009	SW008			74.1	7.14		7.18		16.42	2.4			4474
6/25/2009	SW008			29.1	2.32					26.22			40885
7/24/2009	SW008			22.8	1.68		7.24		22.07	29.43			45385
8/19/2009	SW008			25.4	1.83		7.26		23.16	29.41			25386
10/1/2009	SW008			55.2	4.77		7.31		13.44	30			46251
10/28/2009	SW008			62.2	7.19		7.14		8.44	1.9			3606
11/18/2009	SW008			79.2	9.87		7.6		6.11	0.16			330
12/17/2009	SW008			69.4	8.83		7.12		3.76	5.37			9671
1/16/2009	SW009			35.1	4.51		6.63		4.37	0.25			515
2/26/2009	SW009			87.8	11.95		7.18		2.38	0.37			766
3/18/2009	SW009			139.2	16.83		7.24		6.95	0.36			737
4/30/2009	SW009			105.5	10.49		7.55		15.5	0.45			907
5/11/2009	SW009			49.3	5.353		7.14		11.61	0.26			543
6/25/2009	SW009			64.4	5.65					13.89			22609
7/24/2009	SW009			163.95	13.05		7.935		19.25	23.525			37011.5
8/19/2009	SW009			4.4	0.36		8.13		17.83	27.03			42036
10/1/2009	SW009			5.145	5.61		7.26		12.85	27.44			42703
10/28/2009	SW009			62.4	7.49		7.04		7.38	0.17			346
11/18/2009	SW009			94.5	11.93		6.94		5.46	0.03			69
12/17/2009	SW009			56.4	7.41		6.91		3.85	0.25			525
1/16/2009	SW010			61.4	7.85		6.54		4.89	0.12			243
2/26/2009	SW010			64.7	9.18		6.74		0.97	0.38			738
3/18/2009	SW010			69.9	8.51		7.1		6.82	0.31			643
4/30/2009	SW010			109.5	10.56		7.14		16.91	0.55			1093
5/11/2009	SW010			71.4	7.31		6.94		13.98	0.63			1258
6/25/2009	SW010			14.2	1.39					1.24			2398
7/24/2009	SW010			2.2	0.19		7.09		18.67	19.85			31750
8/19/2009	SW010			1.7	0.12		6.98		19.17	29.17			45092
10/1/2009	SW010			54.7	4.69		7.29		13.66	29.13			44998
10/28/2009	SW010			41.4	4.8		6.44		8.62	1.4			2692
11/18/2009	SW010			59.2	7.26		6.75		6.38	0.45			910
12/17/2009	SW010			37.2	4.89		6.52		3.89	0.48			980
1/16/2009	SW011			107.4	14.1		7.3		3.84	0.06			130
2/26/2009	SW011			113	16.14		6.99		0.73	0.06			129
3/18/2009	SW011			116.3	14.72		7.11		5.33	0.06			128
4/30/2009	SW011			99	10.9		7.53		11.05	0.09			190
5/11/2009	SW011			103.1	11.31		7.25		11.23	0.07			158

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
6/25/2009	SW011			107.7	10.38					0.12			255
7/24/2009	SW011			103.55	10.215		8.175		16.025	0.14			292
8/19/2009	SW011			57.25	5.755		7.16		15.135	0.16			331
10/1/2009	SW011			58.2	6.54		7.3		10.23	0.17			347
10/28/2009	SW011			103.3	12.27		7.08		7.78	0.1			208
11/18/2009	SW011			100.6	12.3		7.27		6.68	0.06			133
12/17/2009	SW011			105.6	14.23		6.65		3	0.05			117
1/16/2009	SW012			70.5	9.05		6.765		4.7	0.09			196
2/26/2009	SW012			92.4	13.07		7.87		1.14	0.08			173
3/18/2009	SW012			86.1	10.56		6.955		6.53	0.1			209
4/30/2009	SW012			59.05	6.025		7.19		14.3	0.15			319
5/11/2009	SW012			55.9	5.88		7.17		13.4	0.13			267
6/25/2009	SW012			47.9	4.2					18.26			29429
7/24/2009	SW012			184	15.72		8.09		19.62	26.12			40861
8/19/2009	SW012			31.1	2.48		7.79		18.08	28.17			43742
10/1/2009	SW012			88.5	7.92		7.42		12.08	28.88			44757
10/28/2009	SW012			51.3	6.02		6.83		8.34	0.09			187
11/18/2009	SW012			62.6	7.6		6.65		7.09	0.08			171
12/17/2009	SW012			74.7	10.075		6.68		2.88	0.08			180
1/16/2009	SW013			62.8	8.07		6.74		4.84	0.11			222
2/26/2009	SW013			61.5	8.42		7.03		2.06	0.61			1242
3/18/2009	SW013			61.2	7.43		6.99		6.84	0.49			983
4/30/2009	SW013			161.3	15.12		7.22		17.85	1.02			1985
5/11/2009	SW013			39.4	4.1		6.93		13.46	0.8			1574.5
6/25/2009	SW013			125.3	10.76					17.4			28141
7/24/2009	SW013			371.3	28.83		8.96		21.58	21.15			33660
8/19/2009	SW013			201.1	16.8		8.19		19.29	16.42			26743
10/1/2009	SW013						7.56		13.9	20.67			32912
10/28/2009	SW013			47	5.51		6.74		8.33	0.59			1173
11/18/2009	SW013			65.3	7.9		6.76		6.87	0.33			685
12/17/2009	SW013			66.8	8.79		6.84		3.66	0.75			1508
1/16/2009	SW014			89.75	11.805		6.54		3.825	0.06			129.5
2/26/2009	SW014			100.8	14.08		6.89		1.6	0.07			154
3/18/2009	SW014			105.4	13.33		6.84		5.27	0.06			128
4/30/2009	SW014			97.35	10.475		7.335		12.035	0.08			163
5/11/2009	SW014			90.9	10.04		6.86		10.9	0.07			150
6/25/2009	SW014			34.5	3.45					0.14			290.5
8/19/2009	SW014			74.9	7.32		7.22		16.32	0.09			184
10/1/2009	SW014			94	9.93		7.8		12.54	0.14			290
10/28/2009	SW014			76	8.92		7.4		8.21	0.07			145
11/18/2009	SW014			70.45	8.575		7.67		6.895	0.07			149
12/17/2009	SW014			83.3	10.92		7.19		4.02	0.06			134
2/11/2009	SW015			34.5	4.54		6.62		3.69	0.46			935
3/27/2009	SW015			68.8	8.04		6.86		8.41	0.69			1369

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
4/22/2009	SW015			84.9	8.8		6.86		13.46	0.82			1622
5/5/2009	SW015			66.05	6.87		6.72		13.11	0.985			1922.5
6/1/2009	SW015			77.4	7.2		6.83		19.06	0.7			1398
7/29/2009	SW015			40.5	3.57		8.37		21.5	1.08			2106
8/18/2009	SW015			70.6	6.825		8.54		17.435	1.125			2184.5
9/30/2009	SW015			21.2	2.36		7.835		10.59	0.97			1889
10/26/2009	SW015	0.24	0.24	11.5	1.32		7.1	6.3	9.14	0.28		7.37	576
11/17/2009	SW015			49.8	5.77		7.54		8.62	1.18			2283
12/28/2009	SW015			31.6	4.295		6.445		2.185	1.085			2146.5
1/13/2009	SW016			45.8	5.59		6.67		6.73	0.16			328
2/11/2009	SW016			85.2	10.97		6.99		4.71	0.31			637
3/27/2009	SW016			72.5	8.49		6.69		8.34	0.44			882
4/22/2009	SW016			108.4	11.14		6.79		13.94	0.51			1021
5/5/2009	SW016			64	6.89		7.05		11.75	0.62			1240
6/1/2009	SW016			92.1	8.59		6.97		18.28	0.55			1108
11/17/2009	SW016						6.63		8.97	0.39			800
2/11/2009	SW017			48	5.95		6.91		5.45	1.04			2042
3/27/2009	SW017			100.3	11.53		6.91		9.08	1.06			2065
4/22/2009	SW017			83	8.39		6.67		14.54	1.14			2220
5/5/2009	SW017			93.4	9.96		6.66		12.05	1.55			2992
6/1/2009	SW017			179.8	16.26		6.805		18.805	1.185			2299
10/26/2009	SW017			39.9	4.5		6.35		9.72	0.88			1743
11/17/2009	SW017			59	6.83		6.72		8.67	0.24			498
12/28/2009	SW017			14.6	1.97		6.75		1.65	0.86			1731
1/13/2009	SW018			97.2	12.36		6.89		5.2	0.05			101
1/5/2009	SW019			102.2	11.01		7.66		3.94	29.03	170		45907
2/17/2009	SW019			106.8	10.92		7.64		5.99	29.56	290		46306
3/24/2009	SW019			109.6	11.01		7.79		6.98	28.85	290		45168
4/20/2009	SW019			150.8	13.88		8.16		10.83	29.01	290		45020
5/29/2009	SW019			108.65	9.03		7.935		15.755	28.86	290		44591.5
6/15/2009	SW019			116.5	9.53					23.18	210		45023
7/28/2009	SW019			107.3	8.29		7.92		20.33	27.99	310		43366
8/27/2009	SW019			80.2	6.57		7.79		16.1	29.93	320		46109
9/9/2009	SW019			89	7.67		7.74		14.05	29.6	320		45666
10/7/2009	SW019			78.1	7.02		7.69		11.7	29.81	310		46078
11/30/2009	SW019			86.8	8.645		7.585		8.285	25.52	130		40269
1/5/2009	SW022			105.1	11.43		7.72		3.96	27.22	80		43270
2/17/2009	SW022			114.4	11.68		7.735		5.95	29.665	79		46447
3/24/2009	SW022			108.9	11.1		7.75		6.42	28.73	220		45109
4/20/2009	SW022			149.8	13.42		8.36		12.33	28.19	94.49		43782
6/15/2009	SW022			108.8	8.29					30.14	54.9		46347
7/28/2009	SW022			105.3	9.04		7.95		14.12	28.67	155.49		44374
8/27/2009	SW022			94.2	8.14		7.96		13.72	29.6	167.64		45675
9/9/2009	SW022			93.9	8.2		7.76		12.84	30.06	140		46332

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
10/7/2009	SW022			84	7.51		7.81		11.86	29.91	118.87		46206
11/30/2009	SW022			91.2	9.01		7.65		8.41	26.33	210		41541
1/5/2009	SW023			106.6	11.75		7.72		4.1	25.5	90		40768
2/17/2009	SW023			107.6	11.36		7.53		5.79	25.63	170		40714
3/24/2009	SW023			108.05	11.025		7.74		6.92	26.83	180		42291
4/20/2009	SW023			119	12.73		7.78		11.39	3.43	80		6253
5/29/2009	SW023			110	10.25		8.01		13.93	15.32	109.728		25057
6/15/2009	SW023			113.6	9.95					17.21	160		27999
7/28/2009	SW023			117.1	9.61		8.16		19.66	18.66	115.82		30036
8/27/2009	SW023			109.55	9.18		8.135		16.74	24.555	176.78		38625.5
9/9/2009	SW023			103.7	9.05		7.98		15.58	21.92	190		34770
10/7/2009	SW023			89.3	8.52		7.42		10.78	22.76	182.88		36122
11/30/2009	SW023			114	13.18		7.86		7.73	4.73	40		8488
1/5/2009	SW024			103.5	12.98		6.5		5.77	0.1			221
1/5/2009	SW025			97.3	12.27		6.75		5.47	0.13			268
1/5/2009	SW026			98.93333333	10.88333333		7.21		5.106666667	21.99333			35482.66667
2/17/2009	SW026			101.75	11.74		7.58		5.39	13.04			21051.5
3/24/2009	SW026			117.7	12.845		7.55		7.94	13.86			21889.5
4/20/2009	SW026			147.7333333	13.04666667		8.163333333		20.95	2.356667			4210
5/29/2009	SW026			106.75	9.23		7.675		19.635	11.4			19150
11/30/2009	SW026			106.35	11.245		7.7		8.185	10.42			16890
1/5/2009	SW027			98.98	12.895		7.455		2.91	5.97			12388.5
2/17/2009	SW027			116.75	13.57	13.36	7.845		5.6	12.305			19651.5
3/24/2009	SW027			102.75	12.365		7.325		7.125	0.1			210
4/20/2009	SW027			117.95	11.715		7.675		14.835	2.97			5225
5/29/2009	SW027			108	10.29666667		7.853333333		16.28666667	4.013333			6733.666667
6/15/2009	SW027			93.45	8.485					12.17			19275
11/30/2009	SW027			104.85	11.73		7.78		7.93	9.095			14081
1/5/2009	SW028			114.2	13.045		7.575		5.355	17.935			29149
2/17/2009	SW028			163	17.50666667		8.1		8.363333333	13.77333			22661
3/24/2009	SW028			138.1	15.44333333		7.92		7.92	10.24333			16416
4/20/2009	SW028			147.4	13.33333333		8.316666667		19.54	2.45			4461.333333
5/29/2009	SW028			134.35	10.605		8.13		22.595	15.39			25152
6/15/2009	SW028			104.3	8.42					23.175			36557
7/28/2009	SW028			117.05	8.615		7.765		25.48	22.57			35793.5
8/27/2009	SW028			103.4	8.255		7.695		19.49	24.51			38441
9/9/2009	SW028			96.5	8.125		7.595		16.725	26.145			32277.5
10/7/2009	SW028			96.3	8.72		7.715		12.455	26.77			22688.5
11/30/2009	SW028			108.45	11.31		7.125		7.99	19.51			31533.5
3/25/2009	SW029			103.9	12.9		6.11		6.1	0.05			104
4/16/2009	SW029			110.6	13.18		6.4		7.75	0.05			108
5/6/2009	SW029			100.9	11.64		6.94		9.01	0.06			120
10/29/2009	SW029			87	10.39		6.21		7.71	0.06			133
11/19/2009	SW029			87.5	10.57		6.38		7.24	0.05			114

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
12/14/2009	SW029			101	14.59		4.8		0.33	0.5			110
1/8/2009	SW030			109.1	14.04		7.37		4.54	0.58			1154
1/12/2009	SW030			115.9	14.31		7.42		5.37	3.76			6955
2/5/2009	SW030			109.8	13.61		7.3		4.79	5.29			9350
3/25/2009	SW030			109.3	10.58		7.8		9.08	27.22			42594
4/16/2009	SW030			115.3	11.13		7.84		14	10.76			18109
5/6/2009	SW030			103.6	11		7.97		11.88	4.04			7286
6/17/2009	SW030			105.8	9.91					2.45			4561
7/30/2009	SW030			125	9.54		8.28		24.39	15.63			25567
8/4/2009	SW030			110.6	8.37		8.3		25.17	13.44			22179
9/16/2009	SW030			116.8	10.21		8		16.05	19.62			31414
10/29/2009	SW030			105.3	11.59		7.7		7.89	11.71			19730
11/19/2009	SW030			107	12.47		7.6		6.59	7.63			13305
12/14/2009	SW030			96.5	11.14		7.47		3.71	19.62			32120
1/8/2009	SW031			75.8	9.41		5.74		6.19	0.05			102
1/12/2009	SW031			90.2	11.37		5.31		5.77	0.05			105
2/5/2009	SW031			80.5	10.58		5.65		3.84	0.04			97
3/25/2009	SW031			100.1	11.78		6.41		8.18	0.04			86
4/16/2009	SW031			112	12.26		6.4		11.31	0.04			88
5/6/2009	SW031			80.3	9.03		6.34		10.16	0.05			112
1/8/2009	SW032			103.9	11.08		7.63		5.64	25.05			39901
1/12/2009	SW032			110.6	12.92		7.29		5.55	11.4			19271
2/5/2009	SW032			107.2	12.94		7.7		3.82	13.79			22624.66
3/25/2009	SW032			140.9	13.84		7.99		8.44	27.19			42654
4/16/2009	SW032			143	13.79		8.34		11.53	19.41			31212
5/6/2009	SW032			107.7	11.78		8.19		10.45	2.98			5506
6/17/2009	SW032			109.8	10.5					2.75			5087
7/30/2009	SW032			121.9	9.45		8.28		23.94	15.58			25755
8/4/2009	SW032			135.3	10.52		8.37		21.87	20.52			32754
9/16/2009	SW032			112.2	9.52		7.96		15.62	25.91			40486
10/29/2009	SW032			103.6	11.2		7.68		8.05	14.09			23373
11/19/2009	SW032			99.4	11.5		7.58		6.65	8.57			14785
12/14/2009	SW032			96.3	10.77		7.6		3.99	23.18			37386
1/8/2009	SW033			68.8	8.85		5.74		5.79	0.04			83
1/12/2009	SW033			86.2	10.89		5.33		5.39	0.04			92
2/5/2009	SW033			65.5	8.64		5.775		3.61	0.05			105
3/25/2009	SW033			79	9.44		6.87		7.67	0.04			95
4/16/2009	SW033			91.5	10.19		6.72		10.61	0.05			100
5/6/2009	SW033			69.4	7.73		6.27		10.53	0.06			125
11/19/2009	SW033			78	9.3		7.665		7.79	0.07			155
1/12/2009	SW034			115.1	13.58		7.53		5.36	9.03			15616
2/5/2009	SW034			109.2	13.4		7.63		4.47	7.29			12833.66
3/25/2009	SW034			155.4	15.04		8.11		9.2	27.7			42688
4/16/2009	SW034			158.9	15.2		8.38		11.43	21.07			33755

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
5/6/2009	SW034			106.2	11.555		7.885		9.715	3.39			6200.5
6/17/2009	SW034			110.9	10.585					3.38			5954
7/30/2009	SW034			122.9	9.56		8.26		23.59	14.98			24645
8/4/2009	SW034			160.1	12.3		8.49		22.37	21.11			33625
9/16/2009	SW034			114.75	9.99		8.005		15.395	23.22			35969.5
10/29/2009	SW034			102.1	10.92		7.65		8.105	15.24			25145.5
11/19/2009	SW034			99.1	11.5		7.42		6.6	8.61			14881
12/14/2009	SW034			99.45	11.15		7.665		3.96	23.17			37371.5
1/12/2009	SW035			62.7	7.805		6.235		5.85	0.18			376
2/5/2009	SW035			98.9	12.69		6.97		4.62	0.56			1123
3/25/2009	SW035			95.35	11.235		7.01		8.175	0.06			121
4/16/2009	SW035			111.2	12.395		6.69		10.49	0.09			189.5
5/6/2009	SW035			75.2	8.28		7.01		10.94	0.41			838
11/19/2009	SW035			51.8	6.23		5.89		7.17	0.08			166
1/12/2009	SW036			120.2	14.28		7.5		5.34	9.06			15660
2/5/2009	SW036			108.8	13.43		7.56		3.86	9.91			17078
3/25/2009	SW036			165.4	16.02		8.17		9.09	27.19			42578
4/16/2009	SW036			137.8	13.69		8.26		10.14	19.24			31059
5/6/2009	SW036			107.8	11.78		7.96		10.09	4.63			8303
6/17/2009	SW036			109	10.07					6.35			11135
7/30/2009	SW036			118.9	9.3		8.2		23.8	14.12			23332
8/4/2009	SW036			122.8	9.68		8.3		20.66	22.24			35222
9/16/2009	SW036			133.6	11.72		8.22		15.94	19.69			31307
10/29/2009	SW036			102.7	11.01		7.63		7.98	15.44			25444
11/19/2009	SW036			99	11.51		7.6		6.54	8.44			14616
12/14/2009	SW036			97.1	10.87		7.56		4.01	23.21			37409
1/12/2009	SW037			90.9	11.05		6.85		6.78	0.21			428
4/16/2009	SW037			78.4	8.89		6.87		9.83	0.21			433
11/19/2009	SW037			83.3	9.53		6.61		9.31	0.14			284
1/12/2009	SW038			118.5	14.27		7.34		5.27	7.65			13400
2/5/2009	SW038			109.8	13.4		7.78		3.9	11.15			19154
3/25/2009	SW038			148.2	14.62		7.99		8.04	27.66			43355
4/16/2009	SW038			129	12.9		8.23		9.77	19.91			32028
5/6/2009	SW038			105.9	11.44		8.06		9.95	7.15			12453
6/17/2009	SW038			108.4	10.14					6.8			11872
7/30/2009	SW038			121.9	9.77		8.23		22.08	14.7			24202
8/4/2009	SW038			138.8	10.49		8.25		22.2	24.53			38525
9/16/2009	SW038			110	9.57		7.69		14.93	24.21			38103
10/29/2009	SW038			102.8	10.97		7.61		8.06	15.71			25853
11/19/2009	SW038			97.5	11.3		7.22		6.46	8.94			15420
12/14/2009	SW038			96.9	10.84		7.52		3.88	23.2			37430
1/12/2009	SW039			99.8	10.25		7.43		6.52	27.07			42710
2/5/2009	SW039			100.7	10.32		7.64		6.34	28.28			44442
3/25/2009	SW039			128.7	12.68		8.28		8.52	28.18			44079
4/16/2009	SW039			130.3	12.57		7.95		8.59	29.42			45778
5/6/2009	SW039			152	14.27		8.24		10.09	28.66			44582
6/17/2009	SW039			125.4	11.07					29.15			45103
7/30/2009	SW039			103.6	9.44		7.84		19.3	23.61			37171

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
8/4/2009	SW039			223.7	17.27		8.54		19.92	27.83			43135
9/16/2009	SW039			111	9.51		7.92		14.03	29.55			45616
10/29/2009	SW039			87.3	8.49		7.24		9.91	25.85			40660
11/19/2009	SW039			96	10.87		7.45		6.74	11.28			19120
12/14/2009	SW039			91.6	9.87		7.26		5.01	25.77			41016
1/13/2009	SW051			77.2	9.07		6.83		5.54	10.22			17541
1/16/2009	SW051			78.4	9.28		6.78		4.73	11.46			19733
2/11/2009	SW051			85.4	10.09		6.75		4.44	13.56			22865
2/26/2009	SW051			108.9	14		7.54		0.56	16.1			27193
3/18/2009	SW051			125.4	12.79		7.99		7.3	25.58			40512
3/27/2009	SW051			99.4	10.65		8.94		7.37	11.94			20039
4/22/2009	SW051			183.9	16.86		8.38		15.7	13.32			22057
4/30/2009	SW051			118.4	9.97		8.05		15.95	26.22			40890
5/5/2009	SW051			94.5	8.84		7.67		12.58	20.75			33138
5/11/2009	SW051			154.6	12.5		8.3		19.52	21.14			33623
6/1/2009	SW051			167.7	12.36		8.03		23.12	26.19			40886
6/25/2009	SW051			91.9	7.62					26.86			41785
7/24/2009	SW051			72.4	5.6		7.9		20.08	27.36			42488
7/29/2009	SW051			92.9	6.45		7.75		25.75	28.76			44555
8/18/2009	SW051			54.7	4.03		7.63		22.61	28.77			44485
8/19/2009	SW051			83.4	6.44		7.82		19.58	28.78			44453
9/30/2009	SW051			97.3	8.47		7.64		13.22	29.43			45470
10/1/2009	SW051			94.3	8.34		7.5		12.68	29.09			45024
10/26/2009	SW051			99.7	9.61		7.6		9.56	26.59			41667
10/28/2009	SW051			75.4	7.88		6.85		8.6	17.09			27909
11/17/2009	SW051			94.2	9.17		7.56		8.88	26.85			42123
11/18/2009	SW051			92.2	10.67		7.17		6.21	10.6			18062
12/17/2009	SW051			94.3	10.07		7.16		6.07	22.92			36728
12/28/2009	SW051			94.8	10.85		7.17		2.18	25.96			41809
1/13/2009	SW052			107.8	11.6		7.65		5.39	24.15			38609
2/11/2009	SW052			117.5	12.73		7.99		4.42	26.83			42635
3/27/2009	SW052			112.4	11.15		7.81		8.05	27.04			42466
4/22/2009	SW052			10.9	127.1		8.32		14.91	28.34			43889
5/5/2009	SW052			115.2	10.17		8.2		12.68	29.54			45645
6/1/2009	SW052			251.6	18.86		8.43		21.86	29.56			45577
7/29/2009	SW052			107	7.25		8.43		26.82	28.8			44651
8/18/2009	SW052			62.4	4.5		7.64		22.84	30.43			46792
9/30/2009	SW052			103.6	8.96		7.76		13.2	30.85			47446
10/26/2009	SW052			112.5	10.64		7.85		9.97	27.67			43199
11/17/2009	SW052			106.8	10.54		7.74		8.14	27.11			42565
12/28/2009	SW052			133.4	16.1		7.95		-0.18	27.55			44749
1/16/2009	SW053			76.3	9.15		6.63		5.09	8.43			15043
2/26/2009	SW053			95.2	13.425		6.915		0.84	1.76			3408
3/18/2009	SW053			105.25	12.9		7.17		5.665	3.415			6246
4/30/2009	SW053			131.6	10.55		8.28		18.15	27.26			42477
5/11/2009	SW053			86.5	8		7.03		16.29	8.28			13917

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
6/25/2009	SW053			93.2	7.78					25.94			40490
7/24/2009	SW053			50.2	3.8		7.69		20.94	27.73			43007
8/19/2009	SW053			26.9	2.06		7.56		20.43	28.44			43994
10/1/2009	SW053			77.6	6.89		7.75		12.63	28.8			44612
10/28/2009	SW053			87	9.55		6.85		8.8	8.25			14248
11/18/2009	SW053			103.1	10.17		7.49		6.44	22.99			36807
12/17/2009	SW053			96.2	9.6		7.56		7.14	29.14			4560
1/13/2009	SW055			63.7	7.97		6.24		5.52	0.1			212
2/11/2009	SW055			27.7	3.49		6.34		4.22	3.31			6122
3/27/2009	SW055			110.4	11.68		7.14		8.42	15.5			25493
4/22/2009	SW055			111	10.93		7.18		12.92	10.98			18481
5/5/2009	SW055			94.2	8.75		7.43		12.01	23.35			36904
6/1/2009	SW055			150.2	12.06		7.52		20.02	21.24			33782
7/29/2009	SW055			70.6	5.15		7.39		23.27	27.17			42268
8/18/2009	SW055			78.8	6.03		7.47		20.09	28.49			44058
9/30/2009	SW055			90	7.73		7.44		13.83	29.38			45380
10/26/2009	SW055			97.8	8.98		7.38		11.54	27.23			42475
11/17/2009	SW055			113.2	11.87		9.01		7.31	15.5			24967
12/28/2009	SW055			28.1	3.36		7.03		3.66	11.01			18863
1/13/2009	SW056			68.85	8.78		6.37		4.97	0.08			177
2/11/2009	SW056			50.5	6.4		6.95		4.79	1.78			3390
3/27/2009	SW056			117.9	13.55		7.35		8.19	3.84			6996
4/22/2009	SW056			119.15	11.805		7.425		14.64	4.14			7455
5/5/2009	SW056			102.8	9.77		7.45		13.15	16.48			26844
6/1/2009	SW056			189.5	15.06		7.51		19.86	22.72			35932
7/29/2009	SW056			168.9	12.02		7.68		24.43	28.89			44765
8/18/2009	SW056			387.37	26.94		8.59		25.3	28.8			44547
9/30/2009	SW056			169	14.04		7.49		15.21	30.5			46844
10/26/2009	SW056			68.9	6.36		7.07		11.87	25.16			39511
11/17/2009	SW056			85.4	9.5		7.33		8.81	5.66			9723
12/28/2009	SW056			56.5	7.81		7.08		0.98	2.93			5402
1/16/2009	SW058			54.9	7.05		6.56		4.88	0.06			119
2/26/2009	SW058			71	9.44		7.08		2.85	2.39			4538
3/18/2009	SW058			96.5	11.35		7.19		7.99	0.98			1915
4/30/2009	SW058			76.7	8.19		6.79		12.81	2.98			5492
5/11/2009	SW058			32.4	3.22		6.68		11.85	1.95			3585
6/25/2009	SW058												
10/28/2009	SW058			73.4	8		6.81		10.3	4.6			8269
11/18/2009	SW058			90.6	11.36		6.89		5.76	0.04			82
12/17/2009	SW058			74.9	9.98		7.08		2.73	1.58			3055
2/11/2009	SW059			41.7	5.46		6.605		3.83	0.44			898.5
3/27/2009	SW059			90.1	10.58		7.015		8.11	0.64			1274
4/22/2009	SW059			124.5	13.01		7.07		13.18	0.81			1590
5/5/2009	SW059			70.1	7.78		7.11		12.17	0.87			1703
6/1/2009	SW059			48.9	4.68		6.89		17.145	0.81			1592
7/29/2009	SW059			26	1.91		7.58		22.95	26.68			41566
8/18/2009	SW059			60.2	4.8		7.95		18.25	27.59			42679
9/30/2009	SW059			57	5.41		7.61		11.67	29.62			45816
10/26/2009	SW059			70.2	7.76		7.03		10.08	0.53			1059

Table A.2 2009 Selected Water Quality Results

Run Date	Site Number	Nitrite (mg/l)	Orthophosphate (mg/l)	Oxygen - % Saturation (%)	Oxygen - Dissolved Field (mg/l)	Oxygen - Dissolved Lab (mg/l)	pH - Field (pH Units)	pH - Lab (pH Units)	pH - Sample Temperature (deg C)	Salinity (ppt)	Secchi Depth (cm)	Silicon (mg/l)	Specific Conductivity - Field (uS/cm)
11/17/2009	SW059			66.3	7.66		7.51		8.54	1.04			2023
12/28/2009	SW059			52.5	7.17		6.77		2.14	1			19.79
1/13/2009	SW072			62.4	7.97		6.14		5.13	0.03			69
2/11/2009	SW072			22.2	2.87		6.55		3.69	0.08			179
3/27/2009	SW072			39.6	4.64		6.72		8.43	0.09			198
4/22/2009	SW072			54	5.32		6.73		15.91	0.11			234
5/5/2009	SW072			55.4	5.78		6.97		13.47	0.12			250
6/1/2009	SW072			27.4	2.5		6.59		20.47	0.12			255
7/29/2009	SW072			84.9	6.8		6.85		27.18	0.13			247
8/18/2009	SW072			96.6	8.25		7.37		23.01	0.14			287
9/30/2009	SW072			93.5	9.53		7.3		14.52	0.14			299
10/26/2009	SW072			49.35	5.66		6.53		9.225	0.1			215
11/17/2009	SW072			49.8	5.88		6.92		8.1	0.13			268
1/12/2009	SW118			110.55	14.175		7.03		4.87	0.05			97
1/16/2009	SW118			107.5	14.04		6.95		4.11	0.05			116
2/5/2009	SW118			108.95	13.93		7.355		4.89	0.06			134
2/11/2009	SW118			105.5	13.68		7.2		4.34	0.07			138
2/26/2009	SW118			108.95	15.11		7.335		1.865	0.05			109.5
3/18/2009	SW118			112.3	13.93		7.15		6.04	0.06			138
3/25/2009	SW118			104.1	12.775		7.73		6.5	0.06			118.5
3/27/2009	SW118			108.05	13.005		7.23		7.31	0.06			121
4/16/2009	SW118			109.15	12.625		7.23		8.965	0.05			106
4/22/2009	SW118			113.9	13.11		6.98		9.05	0.03			73
4/30/2009	SW118			105	11.62		7.47		10.78	0.05			106
5/5/2009	SW118			102.2	11.79		7.31		9.03	0.04			84
5/6/2009	SW118			104.5	12.9		7.44		6.2	0.03			58
5/11/2009	SW118			102.1	11.5		6.06		10.02	0.04			84
6/1/2009	SW118			112.9	12.34		11.24		7.56	0.03			60
6/17/2009	SW118			107.6	11.27					0.03			75
6/25/2009	SW118			117.1	12.53					0.04			82
7/24/2009	SW118			106.6	10.23		7.66		17.32	0.04			83
7/29/2009	SW118			103.7	9.535		7.24		19.43	0.03			62
7/30/2009	SW118			107	9.88		7.33		19.11	0.03			69
8/4/2009	SW118			105.85	9.975		7.21		18.155	0.04			82
8/18/2009	SW118			104.4	9.8		7.43		18.37	0.05			111.5
8/19/2009	SW118			110.6	10.58		7.83		17.455	0.05			106
9/16/2009	SW118			104.8	10.61		7.9		14.74	0.05			107
9/30/2009	SW118			102.6	11.32		7.52		10.92	0.06			124
10/1/2009	SW118			102	11.38		7.77		10.45	0.06			120
10/26/2009	SW118			104.5	12		6.64		7.93	0.04			84
10/28/2009	SW118			109.75	13.385		7.015		6.78	0.45			91
10/29/2009	SW118			101.2	12.3		7.33		6.91	0.05			98
11/19/2009	SW118			96.6	12.04		7.45		5.86	0.04			83
12/14/2009	SW118			99.3	13.83		7.36		1.63	0.06			132
12/17/2009	SW118			105	13.93		7.41		3.62	0.05			116
12/28/2009	SW118			106.2	14.56		9.95		2.31	0.06			123

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
1/19/2009	DH038										5.4		6.58	
3/4/2009	DH038										6.1		6.335	
5/27/2009	DH038										4.5		11.36	
7/23/2009	DH038										3.5		16.67	
9/23/2009	DH038										4.1		13.335	
10/8/2009	DH038										4.3		11.05	
11/4/2009	DH038										5.2		9.1	
1/19/2009	DH039										7.5		6.71	
3/4/2009	DH039										8.4		6.59	
5/27/2009	DH039										6.6		10.62	
7/23/2009	DH039										2.8		16.53	
9/23/2009	DH039										5.8		12.5	
10/8/2009	DH039										6.7		30.16	
11/4/2009	DH039										7.1		9.31	
1/19/2009	DH040										6.1		6.49	
3/4/2009	DH040										6.6		6.77	
5/27/2009	DH040										5.3		10.7	
7/23/2009	DH040										2.9		14.905	
9/23/2009	DH040										5		12.2	
10/8/2009	DH040										5		11.21	
11/4/2009	DH040										5.1		9.49	
1/19/2009	DH041										5.6		6.39	
3/4/2009	DH041										5.9		6.76	
5/27/2009	DH041										4.7		10.755	
7/23/2009	DH041										1.4		16.06	
9/23/2009	DH041										4.6		13.04	
10/8/2009	DH041										4.5		11.15	
11/4/2009	DH041										5.4		9.35	
1/19/2009	DH042										6.6		6.11	
3/4/2009	DH042										6.3		6.74	
5/27/2009	DH042										4.7		11.68	
7/23/2009	DH042										2		16.05	
9/23/2009	DH042										5.4		13.93	
10/8/2009	DH042										5.2		11.13	
11/4/2009	DH042										5.8		28.35	
1/19/2009	DH043										6.7		5.57	
3/4/2009	DH043										7		6.71	
5/27/2009	DH043										6.1		11.38	
7/23/2009	DH043										4.8		15.47	
9/23/2009	DH043										6.5		13.9	
10/8/2009	DH043										6.1		11.39	
11/4/2009	DH043										7		9.25	
1/19/2009	DH044												4.4	
3/4/2009	DH044									2	1		7.34	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
5/27/2009	DH044										1.5		16.82	
7/23/2009	DH044									6.18	0.833		22.53	
9/23/2009	DH044									4	0.67		19.995	
10/8/2009	DH044									2.77	1.2		14.04	
11/4/2009	DH044									5.895	0.5		9.01	
1/19/2009	DH045												4.5	
3/4/2009	DH045									2	1		7.04	
5/27/2009	DH045										0.3		15.59	
7/23/2009	DH045									1.39	0.333		21.415	
9/23/2009	DH045									1.91	0.67		18.99	
10/8/2009	DH045									1.765	0.75		12.75	
11/4/2009	DH045									1.12	0.42		9.175	
1/14/2009	DH048										21.2		6.86	
1/19/2009	DH048										17.7		6.76	
2/5/2009	DH048												6	
5/6/2009	DH048												12	
7/30/2009	DH048													
9/16/2009	DH048												14	
1/14/2009	DH049										5.7		5.41	
1/19/2009	DH049										5		6.53	
2/5/2009	DH049												6	
3/25/2009	DH049												8	
5/6/2009	DH049												11	
7/30/2009	DH049													
9/16/2009	DH049												14	
1/14/2009	DH050												5.54	
1/19/2009	DH050										3		6.53	
2/5/2009	DH050												5	
3/25/2009	DH050												8	
5/6/2009	DH050												11	
7/30/2009	DH050													
9/16/2009	DH050												14	
1/14/2009	DH051										3.9		5.43	
1/19/2009	DH051										3.3		6.53	
2/5/2009	DH051												5	
3/25/2009	DH051												8	
5/6/2009	DH051												11	
7/30/2009	DH051													
9/16/2009	DH051												14	
1/14/2009	DH052												5.61	
1/19/2009	DH052										0.5		6.05	
2/5/2009	DH052												5	
3/25/2009	DH052												8	
5/6/2009	DH052												10	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
7/30/2009	DH052													
9/16/2009	DH052												14	
1/14/2009	DH053										13.2		5.5	
1/19/2009	DH053										6.6		4.64	
2/5/2009	DH053												6	
3/25/2009	DH053												8	
5/6/2009	DH053												11	
7/30/2009	DH053													
9/16/2009	DH053												14	
1/14/2009	DH054										4		5.47	
1/19/2009	DH054										3.6		4.3	
2/5/2009	DH054												6	
3/25/2009	DH054												8	
5/6/2009	DH054												11	
7/30/2009	DH054													
9/16/2009	DH054												14	
1/14/2009	DH055										6.6		5.36	
1/19/2009	DH055										5.6		5.03	
2/5/2009	DH055												6	
3/25/2009	DH055												8	
5/6/2009	DH055												11	
7/30/2009	DH055													
9/16/2009	DH055												14	
1/14/2009	DH057										3.1		5.685	
1/19/2009	DH057										8.5		5.71	
2/5/2009	DH057												6	
3/25/2009	DH057												8	
5/6/2009	DH057												10	
7/30/2009	DH057													
9/16/2009	DH057												14	
1/14/2009	DH058										2.2		5.61	
1/19/2009	DH058										4.5		6.16	
2/5/2009	DH058												6	
3/25/2009	DH058												8	
5/6/2009	DH058												10	
7/30/2009	DH058													
9/16/2009	DH058												14	
1/14/2009	DH271										7		5.49	
1/19/2009	DH271										6.1		6.52	
2/5/2009	DH271												5	
3/25/2009	DH271												8	
5/6/2009	DH271												11	
7/30/2009	DH271													
9/16/2009	DH271												14	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
1/14/2009	DH272										5		5.46	
1/19/2009	DH272										4.6		6.61	
2/5/2009	DH272												6	
3/25/2009	DH272												8	
5/6/2009	DH272												11	
7/30/2009	DH272													
9/16/2009	DH272												14	
1/19/2009	DH285										2.8		5.7	
3/4/2009	DH285										4		5.89	
5/27/2009	DH285										3.3		13.68	
7/23/2009	DH285										3.1		18.68	
9/23/2009	DH285										3.8		12.9	
10/8/2009	DH285										3		10.93	
11/4/2009	DH285										4.2		9.1	
1/19/2009	DH286										1.8		5.37	
3/4/2009	DH286										2.3		6.5	
5/27/2009	DH286										1.5		11.94	
7/23/2009	DH286										1.2		17.1	
9/23/2009	DH286										1.3		14.63	
10/8/2009	DH286										1.2		9.16	
11/4/2009	DH286										2.5		6.89	
1/19/2009	DH287										5.1		6.54	
3/4/2009	DH287										6.3		6.32	
5/27/2009	DH287										4.8		12.09	
7/23/2009	DH287										3.6		16.9	
9/23/2009	DH287										4.4		12.42	
10/8/2009	DH287										4.4		11.155	
11/4/2009	DH287										4.9		9.08	
1/19/2009	DH288										2.1		4.99	
3/4/2009	DH288										2.9		6.42	
5/27/2009	DH288										2		11.29	
7/23/2009	DH288										2.1		15.33	
9/23/2009	DH288										2		13.04	
10/8/2009	DH288										2.3		10.86	
11/4/2009	DH288										2.5		8.95	
1/5/2009	SW001										11.7		3.98	
2/17/2009	SW001										11		5.97	
3/24/2009	SW001										10.8		6.96	
4/20/2009	SW001										8.8		11.48	
5/29/2009	SW001										6.9		15.94	
6/15/2009	SW001										10		18.06	
7/28/2009	SW001										11.7		17.88	
8/27/2009	SW001										12.7		15.35	
9/9/2009	SW001										11.9		14.64	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
10/7/2009	SW001										11.9		11.96	
11/30/2009	SW001										14.6		8.25	
1/5/2009	SW002										3		5.64	
2/17/2009	SW002										3.1		6.15	
3/24/2009	SW002										2.1		6.86	
4/20/2009	SW002										2.4		11.38	
6/15/2009	SW002										1.8		15.45	
7/28/2009	SW002										4.7		16.13	
8/27/2009	SW002										5.8		15.19	
9/9/2009	SW002										4.2		13.9	
10/7/2009	SW002										4.4		11.565	
11/30/2009	SW002										4.8		8.42	
1/16/2009	SW003									47			4.05	
2/26/2009	SW003									67	3	0	0.78	
3/18/2009	SW003									14	3.5		5.51	
4/30/2009	SW003									14	2.5	-0.5	12.84	
5/11/2009	SW003									9.29	2	-1.5	12.67	
6/25/2009	SW003									5.38	1.25	-0.25	19.03	
7/24/2009	SW003									3.31	2.5	0	21.38	
8/19/2009	SW003									7.57	2	-0.5	21.94	
10/1/2009	SW003									9.01	1	-0.25	13.5	
10/28/2009	SW003									10.85		-0.5	10.85	
11/18/2009	SW003									16.9	3	1	6.93	
12/17/2009	SW003									23.7	4.5	1	2.2	
11/17/2009	SW004									916.5	3	5	6.07	
11/18/2009	SW004									250	2		5.13	
1/5/2009	SW006										11		4.23	
2/17/2009	SW006										8.6		5.66	
3/24/2009	SW006										6.4		6.78	
4/20/2009	SW006										11.2		11.77	
5/29/2009	SW006										6.62		14.47	
6/15/2009	SW006										6.1		17.05	
7/28/2009	SW006										12.6		19.465	
8/27/2009	SW006										14.3		16.37	
9/9/2009	SW006										7.6		15.26	
10/7/2009	SW006										13.4		11.64	
11/30/2009	SW006										15.6		7.95	
1/13/2009	SW007									73	3	4	5.22	
3/25/2009	SW007									42	2.5	-7	6.8	
4/16/2009	SW007									30.3	2.75	-5	9.49	
5/6/2009	SW007									476	5	1.5	6.25	
6/17/2009	SW007									21.65	2.5	-1.5	13.43	
7/30/2009	SW007									113.5	2.5		19.615	
8/4/2009	SW007									57.5	0.833	-2	18.1	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
10/29/2009	SW007									45.9	2		6.94	
11/19/2009	SW007									130	3		5.835	
12/14/2009	SW007									7.01	0.67		1.51	
1/16/2009	SW008									33	1	-1.5	4.36	
2/26/2009	SW008									73	0.5	-9	1.94	
3/18/2009	SW008									25	1.5	-2	6.37	
4/30/2009	SW008									25	1	-3	16.59	
5/11/2009	SW008									18.3	0.667	-5	16.42	
6/25/2009	SW008									19	0.83	-2.5	18.71	
7/24/2009	SW008									19.3	0.833	4.75	22.07	
8/19/2009	SW008									24.1	0.42	-2.5	29.41	
10/1/2009	SW008									22.3	0.67	-2	13.44	
10/28/2009	SW008									23.1	2	-4	8.44	
11/18/2009	SW008									187	1.75	0	6.11	
12/17/2009	SW008									40.45	1.75		3.76	
1/16/2009	SW009									7	3.5	-1	4.37	
2/26/2009	SW009									67	1.5	-2.5	2.38	
3/18/2009	SW009									10	1	-2	6.95	
4/30/2009	SW009									8	1.5	-3.5	15.5	
5/11/2009	SW009									13.4	1.25	-1.5	11.61	
6/25/2009	SW009									63.6	0.5	-1.5	17.46	
7/24/2009	SW009									66.2	1	-2	19.25	
8/19/2009	SW009									49	1	-2	17.83	
10/1/2009	SW009									19.15	0.83	-1.25	12.85	
10/28/2009	SW009									72.8	1.5	-1.75	7.38	
11/18/2009	SW009									156.5	3.25	0.75	5.46	
12/17/2009	SW009									29.4	2.5	-1	3.85	
1/16/2009	SW010									40	6	4.5	4.89	
2/26/2009	SW010									16	3	-0.5	0.97	
3/18/2009	SW010									7	4	-1	6.82	
4/30/2009	SW010									27	2.5	-1	16.91	
5/11/2009	SW010									13.1	2	-2	13.98	
6/25/2009	SW010									14.1	1.5	-0.75	16.15	
7/24/2009	SW010									43.8	1.5	-1	19.85	
8/19/2009	SW010									37.4	1.3	0.25	19.17	
10/1/2009	SW010									10.6	1	0.5	13.66	
10/28/2009	SW010									7.2	1.5	-0.5	8.62	
11/18/2009	SW010									47.4	3	0.333	6.38	
12/17/2009	SW010									70.05	3.5	1.25	3.89	
1/16/2009	SW011									5	1.5	0.5	3.84	
2/26/2009	SW011									19	2.5	0	0.73	
3/18/2009	SW011									11	2	-3	5.33	
4/30/2009	SW011									3	1	-1	11.05	
5/11/2009	SW011									18.5	1.5		11.23	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
6/25/2009	SW011									9.8	0.83	-2	13.96	
7/24/2009	SW011									4.42	1.5	-2	16.025	
8/19/2009	SW011									11.65	0.92	-1.5	15.02	
10/1/2009	SW011									20.8	0.58	-2.5	10.23	
10/28/2009	SW011									7.73	1	-1.25	7.78	
11/18/2009	SW011									13.9	2		6.68	
12/17/2009	SW011									16	1.25		3	
1/16/2009	SW012									2	3	1.5	4.7	
2/26/2009	SW012									15	4	1	1.14	
3/18/2009	SW012									4.5	2	-0.5	6.53	
4/30/2009	SW012									5.5	1	-2	14.3	
5/11/2009	SW012									2.94	1	-4	13.4	
6/25/2009	SW012									26.3	0.5	-1.25	16.33	
7/24/2009	SW012									47.7	0.8333	-5	19.62	
8/19/2009	SW012									34.4	0.75	-0.75	18.08	
10/1/2009	SW012									36.4	0.5	-1	12.08	
10/28/2009	SW012									2.68	2		8.34	
11/18/2009	SW012									3.5	2.5		7.09	
12/17/2009	SW012									10.1	2.75		2.88	
1/16/2009	SW013									20	5	2	4.84	
2/26/2009	SW013									64.5	4	0	2.06	
3/18/2009	SW013									35	4	0	6.84	
4/30/2009	SW013									83	2.5	-0.5	17.85	
5/11/2009	SW013									20.9	3	-1	13.46	
6/25/2009	SW013									24.8	2.25	-0.5	17.7	
7/24/2009	SW013									342.5	2	-2	21.58	
8/19/2009	SW013									175	0.83	-2	19.29	
10/1/2009	SW013									61.1	0.33	-1	13.9	
10/28/2009	SW013									94.5	2	0.5	8.33	
11/18/2009	SW013									135	4.75	0.5	6.87	
12/17/2009	SW013									161	5	2	3.66	
1/16/2009	SW014									9	2	1	3.825	
2/26/2009	SW014									34	2	0	1.6	
3/18/2009	SW014									15	1.5		5.27	
4/30/2009	SW014									11.5	1		12.035	
5/11/2009	SW014									19.7	1		10.9	
6/25/2009	SW014									12.05	0.75		15.365	
8/19/2009	SW014									4.73	0.54		16.32	
10/1/2009	SW014									31.3	0.5		12.54	
10/28/2009	SW014									12.1	1.25		8.21	
11/18/2009	SW014									11.2	1.5		6.895	
12/17/2009	SW014									13.4	1.25		4.02	
2/11/2009	SW015									54	4	0	3.69	
3/27/2009	SW015									32	2.5	0	8.41	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
4/22/2009	SW015									12	3.25	-2	13.46	
5/5/2009	SW015									11.1	3	-1.5	13.11	
6/1/2009	SW015									15.65	5	0.75	19.06	
7/29/2009	SW015									7.44	2	-1.5	21.5	
8/18/2009	SW015									11.75	2.5	-1.7	17.435	
9/30/2009	SW015									29.6	1.5	-1.5	10.59	
10/26/2009	SW015		38	0.09	1.1	19.3	0.72	12	2.1	14.5	3	-0.667	9.14	8.4
11/17/2009	SW015									33.15	3.5	0.5	8.62	
12/28/2009	SW015									16.2	4	0	2.185	
1/13/2009	SW016									64	3.75	3	6.73	
2/11/2009	SW016										1.5	0	4.71	
3/27/2009	SW016									7	2.5	-0.5	8.34	
4/22/2009	SW016									17	2	-1.25	13.94	
5/5/2009	SW016									30.2	2.25	1	11.75	
6/1/2009	SW016									32.25	0.67	-1.5	18.28	
11/17/2009	SW016									40.35	2		6.63	
2/11/2009	SW017									132	2	1	5.45	
3/27/2009	SW017									8	2.5	0	9.08	
4/22/2009	SW017									9	3	-0.333	14.54	
5/5/2009	SW017									43.2	1	-0.5	12.05	
6/1/2009	SW017									54.35	1.5	-0.5	18.805	
10/26/2009	SW017									6.76	0.58	-1.25	9.72	
11/17/2009	SW017									37.55	1.5	0.5	8.67	
12/28/2009	SW017									17.5	1.5	0	1.65	
1/13/2009	SW018									73	1	5	5.2	
1/5/2009	SW019										14.3		3.94	
2/17/2009	SW019										11.7		5.99	
3/24/2009	SW019										13.1		6.98	
4/20/2009	SW019										12.5		10.83	
5/29/2009	SW019										8.6		15.755	
6/15/2009	SW019										12.3		16.38	
7/28/2009	SW019										14.6		20.33	
8/27/2009	SW019										16.1		16.1	
9/9/2009	SW019										13.9		14.05	
10/7/2009	SW019										13.6		11.7	
11/30/2009	SW019										17.3		8.285	
1/5/2009	SW022										4.6		3.96	
2/17/2009	SW022	46465									2.6		6.023333333	
3/24/2009	SW022										2.2		6.42	
4/20/2009	SW022										3.1		12.33	
6/15/2009	SW022										1.8		19.94	
7/28/2009	SW022										5.1		14.12	
8/27/2009	SW022										5.5		13.72	
9/9/2009	SW022										4.6		12.84	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
10/7/2009	SW022										3.9		11.86	
11/30/2009	SW022										6		8.41	
1/5/2009	SW023										8.5		4.1	
2/17/2009	SW023										5.6		5.79	
3/24/2009	SW023										6.4		6.92	
4/20/2009	SW023										3.6		11.39	
5/29/2009	SW023										3.6		13.93	
6/15/2009	SW023										5		16.78	
7/28/2009	SW023										3.8		19.66	
8/27/2009	SW023										5.8		16.74	
9/9/2009	SW023										5.3		15.58	
10/7/2009	SW023										6		10.78	
11/30/2009	SW023										7.1		7.73	
1/5/2009	SW024									4	0.29		5.77	
1/5/2009	SW025									8	0.25		5.47	
1/5/2009	SW026									3	1.33		5.106666667	
2/17/2009	SW026									6.5	1.083		5.39	
3/24/2009	SW026									4.5	0.9585		7.94	
4/20/2009	SW026									17.5	0.2125	0.333	20.88333333	
5/29/2009	SW026									14.5	0.5835	-1	19.635	
11/30/2009	SW026									9.42			8.185	
1/5/2009	SW027									7.66666667	0.625		2.39	
2/17/2009	SW027									7	0.4165	-2	5.6	
3/24/2009	SW027									4.5	0.292		7.125	
4/20/2009	SW027									7.5	0.333		14.835	
5/29/2009	SW027									9.66666667	0.5415		14.39666667	
6/15/2009	SW027									7.845	0.5815	-4	16.34	
11/30/2009	SW027									12.55	1.5	-1.25	7.93	
1/5/2009	SW028									5	0.75	-1.5	5.355	
2/17/2009	SW028									5	0.4585		8.363333333	
3/24/2009	SW028									8	0.625		7.92	
4/20/2009	SW028									20	0.625		19.54	
5/29/2009	SW028									33	0.665		22.595	
6/15/2009	SW028									12	0.71	-2	18.785	
7/28/2009	SW028									9.935	0.585		24.395	23.31
8/27/2009	SW028									10.015	0.7515	-1.5	19.49	
9/9/2009	SW028									11.415	0.621	-2.25	16.725	
10/7/2009	SW028									14.705	0.75	-2	12.455	
11/30/2009	SW028									12.8333333	1.25	0	7.99	
3/25/2009	SW029									12.5	0.583	-2.5	6.1	
4/16/2009	SW029									11.3	0.667	-1.25	7.75	
5/6/2009	SW029									15.9	0.5	-1.25	9.01	
10/29/2009	SW029									19.4	0.25	-0.75	7.71	
11/19/2009	SW029									23.4	0.833		6.38	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
12/14/2009	SW029									7.28	0.667		0.33	
1/8/2009	SW030									821	1.5	3.5	4.54	
1/12/2009	SW030									56	1.5		5.37	
2/5/2009	SW030									6	1		4.79	
3/25/2009	SW030									3	1.5		9.08	
4/16/2009	SW030									64.2	1.25		14	
5/6/2009	SW030									31.3	1		11.88	
6/17/2009	SW030									60.6	1.5		17.84	
7/30/2009	SW030									7.26	3		24.39	
8/4/2009	SW030									29.3	1		25.17	
9/16/2009	SW030									5.41	1.5		16.05	
10/29/2009	SW030									69.4	1		7.89	
11/19/2009	SW030									329	1.5		6.59	
12/14/2009	SW030									5.8	0.75		3.71	
1/8/2009	SW031									10	0.75	1	6.19	
1/12/2009	SW031									8	0.33		5.77	
2/5/2009	SW031									20	0.833	-0.25	3.84	
3/25/2009	SW031									15	1.5		8.18	
4/16/2009	SW031									19.1	0.167		11.31	
5/6/2009	SW031									11.6	0.583		10.16	
1/8/2009	SW032									9	3.75		5.64	
1/12/2009	SW032									20	3		5.55	
2/5/2009	SW032									3	2		3.82	
3/25/2009	SW032									2	1.5		8.44	
4/16/2009	SW032									12.2	1.5		11.53	
5/6/2009	SW032									39	2.75		10.45	
6/17/2009	SW032									15.5	2.5		16.7	
7/30/2009	SW032									6.88	2.75		23.94	
8/4/2009	SW032									12.7	2		21.87	
9/16/2009	SW032									5.02	3		15.62	
10/29/2009	SW032									27.2	1.25		8.05	
11/19/2009	SW032									165	0.833		6.65	
12/14/2009	SW032									4.3	1.25		3.99	
1/8/2009	SW033									24	0.67	0.33	5.79	
1/12/2009	SW033									16	0.29		5.39	
2/5/2009	SW033									54	0.167		3.61	
3/25/2009	SW033									26	0.25		7.67	
4/16/2009	SW033									18.9	0.25		10.61	
5/6/2009	SW033									35.7	0.0417		10.53	
11/19/2009	SW033									48.15	0.333		7.79	
1/12/2009	SW034									34	3		5.36	
2/5/2009	SW034									6	1.75		4.47	
3/25/2009	SW034									2	1.5		9.2	
4/16/2009	SW034									19.9	1.25		11.43	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
5/6/2009	SW034									41.7	1.75		9.715	
6/17/2009	SW034									17.65	2.5		16.675	
7/30/2009	SW034									6.06	2.5		23.59	
8/4/2009	SW034									6.77	1.5		22.37	
9/16/2009	SW034									9.18	2.5		15.395	
10/29/2009	SW034									35.45	1.5		8.105	
11/19/2009	SW034									151	1		6.6	
12/14/2009	SW034									4.425	1.25		3.96	
1/12/2009	SW035									23	0.5		5.865	
2/5/2009	SW035									52	0.125	-0.333	4.62	
3/25/2009	SW035									8	0.417		8.175	
4/16/2009	SW035									5.105	0.19		10.49	
5/6/2009	SW035									5.71	0.1667		10.94	
11/19/2009	SW035									5.08	0.375		7.71	
1/12/2009	SW036									28	3		5.34	
2/5/2009	SW036									4	2		3.86	
3/25/2009	SW036									1	1.5		9.09	
4/16/2009	SW036									9.3	2		10.14	
5/6/2009	SW036									37.5	2.25		10.09	
6/17/2009	SW036									79.4	1		17.28	
7/30/2009	SW036									10.4	2.5		23.8	
8/4/2009	SW036									3.41	1.5		20.66	
9/16/2009	SW036									8.06	2		15.94	
10/29/2009	SW036									33.1	1.5		7.98	
11/19/2009	SW036									102	1.5		6.54	
12/14/2009	SW036									5.09	1.75		4.01	
1/12/2009	SW037									8	0.33		6.78	
4/16/2009	SW037									2.34	2.75		9.83	
11/19/2009	SW037									14.9	2.5		9.31	
1/12/2009	SW038									34	2.5		5.27	
2/5/2009	SW038									4	1.5		3.9	
3/25/2009	SW038									2	1.25		8.04	
4/16/2009	SW038									5.64	2.5		9.77	
5/6/2009	SW038									33.9	1		9.95	
6/17/2009	SW038									35.4	2		16.55	
7/30/2009	SW038									7.1	2		22.1	
8/4/2009	SW038									11.7	1.5		22.2	
9/16/2009	SW038									8.25	2		14.93	
10/29/2009	SW038									20.8	1.5		8.06	
11/19/2009	SW038									63.2	2.25		6.46	
12/14/2009	SW038									4.91	2		3.88	
1/12/2009	SW039									7	2.5		6.52	
2/5/2009	SW039									13	1.5		6.34	
3/25/2009	SW039									42	1		8.52	
4/16/2009	SW039									1.65	2.25		8.59	
5/6/2009	SW039									4.76	1.75		10.09	
6/17/2009	SW039									11.2	2		12.73	
7/30/2009	SW039									3.34	1.5		19.3	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
8/4/2009	SW039									15.6	1		19.92	
9/16/2009	SW039									19.5	1.5		14.03	
10/29/2009	SW039									7	1.5		9.91	
11/19/2009	SW039									58.4	2.5		6.74	
12/14/2009	SW039									4.22	2.6		5.01	
1/13/2009	SW051									90	0.75	4	5.54	
1/16/2009	SW051									70	1.25	5	4.73	
2/11/2009	SW051									19	1.25		4.44	
2/26/2009	SW051									29.5	1		0.44	
3/18/2009	SW051									6	0.5	-1	7.3	
3/27/2009	SW051									20		-6.5	8.94	
4/22/2009	SW051									18	0.417	-6	15.7	
4/30/2009	SW051									6	1	-4	15.95	
5/5/2009	SW051									18.6	0.667	-6	12.58	
5/11/2009	SW051									14.2	0.5	-9	19.52	
6/1/2009	SW051										0.25	-4.5	23.12	
6/25/2009	SW051									22.4	0.67	-4.5	16.56	
7/24/2009	SW051									7.63	0.833	-6	20.08	
7/29/2009	SW051									7.33	0.33	-2.5	25.75	
8/18/2009	SW051									12.7	0.583	-8	22.61	
8/19/2009	SW051									5.72	0.54	-5	19.58	
9/30/2009	SW051									9.67	0.75	-4	13.22	
10/1/2009	SW051									9.65	0.33	-4.5	12.68	
10/26/2009	SW051									8.15	0.833	2	9.56	
10/28/2009	SW051									15.1	0.833	-4	8.6	
11/17/2009	SW051									10.8	0.5	4	8.88	
11/18/2009	SW051									80.7	1	-0.5	6.21	
12/17/2009	SW051									6.86	1.1	-4	6.07	
12/28/2009	SW051									4.14	0.5	2	2.18	
1/13/2009	SW052									1	0.75	2	5.39	
2/11/2009	SW052									1	1		4.42	
3/27/2009	SW052									6.5	0.833		8.05	
4/22/2009	SW052									2	0.833		14.91	
5/5/2009	SW052									13	0.5		12.68	
6/1/2009	SW052									1.145	0.75		21.86	
7/29/2009	SW052									0.9	0.83		26.82	
8/18/2009	SW052									1.46	0.67		22.84	
9/30/2009	SW052									1.24	0.75		13.2	
10/26/2009	SW052									1.64	0.667		9.97	
11/17/2009	SW052									10.01	0.67	3	8.14	
12/28/2009	SW052									6.645	0.5	-3.5	-0.18	
1/16/2009	SW053									21	3		5.09	
2/26/2009	SW053									53	1.75		0.84	
3/18/2009	SW053									22	2		5.665	
4/30/2009	SW053									9	1.5		18.15	
5/11/2009	SW053									12.1	2.5		16.29	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
6/25/2009	SW053									4.55			16.57	
7/24/2009	SW053									5.78	2.5		20.94	
8/19/2009	SW053									6.37	3		20.43	
10/1/2009	SW053									8.4	1.25		12.63	
10/28/2009	SW053									23	2.5		8.8	
11/18/2009	SW053									39.7	2		6.44	
12/17/2009	SW053									5.2	1.8		7.14	
1/13/2009	SW055									134	8	7	5.52	
2/11/2009	SW055									55	2	-0.5	4.22	
3/27/2009	SW055									14	2.5	0.25	8.42	
4/22/2009	SW055									17	1	-1.25	12.92	
5/5/2009	SW055									3.48	1	2	12.01	
6/1/2009	SW055									16.8	1.25	-0.42	20.02	
7/29/2009	SW055									5.32	1	-0.5	23.27	
8/18/2009	SW055									6.84	1.2	-0.5	20.9	
9/30/2009	SW055									3.89	1	-0.5	13.83	
10/26/2009	SW055									6.64	0.833	-0.5	11.54	
11/17/2009	SW055									13.4	2.5	0.333	9.01	
12/28/2009	SW055									20.35	1.25	-0.25	3.66	
1/13/2009	SW056									180	9	5	4.97	
2/11/2009	SW056									36	3	-1	4.79	
3/27/2009	SW056									16	0.833	0.5	8.19	
4/22/2009	SW056									19	0.458	-3.5	14.64	
5/5/2009	SW056									9.68	0.833	-0.75	13.15	
6/1/2009	SW056									14.5	1	-0.5	19.86	
7/29/2009	SW056									15.7	1	-0.75	24.43	
8/18/2009	SW056									24.7	0.83	-1.5	25.3	
9/30/2009	SW056									28.7	1	-0.333	15.21	
10/26/2009	SW056									13	0.667	-0.5	11.87	
11/17/2009	SW056									11.2	1.5	2	8.81	
12/28/2009	SW056									15.3	1.25	-0.25	0.98	
1/16/2009	SW058									179	2	5	4.88	
2/26/2009	SW058									29.5	1.25	0	2.85	
3/18/2009	SW058									26	1.5	0	7.99	
4/30/2009	SW058									60	1	-2	12.81	
5/11/2009	SW058									50.1	1.5	-1	11.85	
6/25/2009	SW058									49.7		-0.48		
10/28/2009	SW058									78.6	0.5	-0.5	10.3	
11/18/2009	SW058									188	2		5.76	
12/17/2009	SW058									51.4	3		2.73	
2/11/2009	SW059									45.5	3		3.83	
3/27/2009	SW059									18.5	2	0.25	8.11	
4/22/2009	SW059									11		-0.5	13.18	
5/5/2009	SW059									12.7	0.833	-1.25	12.17	
6/1/2009	SW059									21.3	1.5	-1	17.145	
7/29/2009	SW059									31.2	1.25	-0.5	22.95	
8/18/2009	SW059									6.97	1	-0.5	18.25	
9/30/2009	SW059									15.9	1.25	-0.25	11.67	
10/26/2009	SW059									11.4	1	-0.25	10.08	

Table A.3 2009 Selected Water Quality Results

Run Date	Site Number	Specific Conductivity - Lab (uS/cm)	Sulfate (mg/l)	Sulfide (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)	Total Suspended Solids (mg/l)	Total Volatile Suspended Solids (mg/l)	Turbidity (NTU)	Water Depth (ft)	Water Level (VG) (ft)	Water Temperature - In Situ (deg C)	Water Temperature - pH Lab (deg C)
11/17/2009	SW059									13.55	1.5	0.5	8.54	
12/28/2009	SW059									12.4	1.5	0	2.14	
1/13/2009	SW072									68	3.5	2.5	5.13	
2/11/2009	SW072									12	3		3.69	
3/27/2009	SW072									7	2.5	-0.5	8.43	
4/22/2009	SW072									4	4	0	15.91	
5/5/2009	SW072									4.27	2		13.47	
6/1/2009	SW072									18.3	2.5	0	20.47	
7/29/2009	SW072									21.4	0.833	-0.5	27.18	
8/18/2009	SW072									6.28	0.75	-2.5	23.01	
9/30/2009	SW072									4.46	1		14.52	
10/26/2009	SW072									32.7	2.5		9.225	
11/17/2009	SW072									7.96	2.75	0.33	8.1	
1/12/2009	SW118									114.5			4.87	
1/16/2009	SW118									35	2	0	4.11	
2/5/2009	SW118									9	2	-1	4.89	
2/11/2009	SW118									9	1.25	0	4.34	
2/26/2009	SW118									58.5	1	0	1.865	
3/18/2009	SW118									21	1.5		6.04	
3/25/2009	SW118									36	2	0	6.5	
3/27/2009	SW118									10	1.5	-0.5	7.31	
4/16/2009	SW118									28.05	1.25		8.965	
4/22/2009	SW118									64	1	0	9.05	
4/30/2009	SW118									7	1.5	-2	10.78	
5/5/2009	SW118									27.1	0.5	0	9.03	
5/6/2009	SW118									45.9	2.25	2	6.2	
5/11/2009	SW118									23	2	1	10.02	
6/1/2009	SW118									125	0.83	1	11.24	
6/17/2009	SW118									23.4	2.75	-0.5	13.16	
6/25/2009	SW118									20.55	1	-0.5	12.29	
7/24/2009	SW118									19	2	-0.5	17.32	
7/29/2009	SW118									164	0.83	-2	19.43	
7/30/2009	SW118									154	1.5	-0.5	19.11	
8/4/2009	SW118									66.55	1.5	0	18.155	
8/18/2009	SW118									12.1	1.5	-1	18.37	
8/19/2009	SW118									22.55	1.1	-1.25	17.455	
9/16/2009	SW118									22.9	2	-2	14.74	
9/30/2009	SW118									10.3	0.67	-0.5	10.92	
10/1/2009	SW118									10.5	1	-0.25	10.45	
10/26/2009	SW118									168	2.5	0.5	7.93	
10/28/2009	SW118									87.45	1	0	6.78	
10/29/2009	SW118									50.8	1.25	-0.5	6.91	
11/19/2009	SW118									123	3.5		5.86	
12/14/2009	SW118									9.1	0.67	-1	1.63	
12/17/2009	SW118									130	0.667	-0.5	3.62	
12/28/2009	SW118									8.625	0.75	-1	2.31	